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Forthcoming Events.

NOVEMBER 26.

Institution of Production Engineers:—General meeting in London. "The Application of Manufacturing Methods to Non-repetition Work," Paper by H. C. Armitage.

NOVEMBER 30.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Some Notes on Steelworks Refractories," Paper by R. J. Sarjant, M.Sc., D.I.C.

Institute of British Foundrymen.

NOVEMBER 27.

Birmingham, Coventry and West Midlands Branch:—Visit to Austin Motor Company, Limited, Birmingham.

Newcastle-on-Tyne Branch:—Visit to Messrs. Wm. Doxford & Sons, Limited, also ordinary meeting at Sunderland. "Common Troubles of the Iron Founder," Paper by F. Allan.

East Midlands Branch:—Ordinary meeting at Loughborough. "Impressions of American Foundries," Paper by S. H. Russell.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Selling Castings.

In recent years the great metallurgical companies of Great Britain have insisted that their salesmen should be technically-trained men—men who are capable of rendering technical service to their individual customers. Undoubtedly, this was a move in the right direction, but we believe it has introduced a serious fault, inasmuch as that a large percentage of these modern salesmen lack the essential quality of being naturally able to sell things. An intense technical knowledge of the goods handled is a totally insufficient qualification, and sometimes it is a definite handicap where the technical enthusiast wastes too much time on work which would normally be "farmed" out to a consulting engineer. For the actual selling of castings, the problem is indeed a hard one, for, generally speaking, a batch of salesmen who could quote during the course of ordinary business calls against either patterns or drawings, would create no end of trouble. The foundry foreman would be liable to find his output quite out of balance, as probably a certain section of his shop would be overloaded with work and other sections starved.

We believe it would be to the advantage of the industry, except for one-man concerns, for every salesman to be prohibited from quoting, their duty being solely the obtaining of inquiries, as they cannot know what business either the post or their colleagues have brought in. It sometimes happens that a job which is welcomed one day may be a nuisance six weeks later. Every mixed foundry has a certain number of "special" customers, and if this type of client suddenly requires some work in a hurry, promises to other people go by the board. There is only one reasonable way of conducting a successful foundry business, and that is by:—(1) The institution of one man or a sales department to quote and accept orders; (2) the construction by that department of business trend curves. These latter would include (*a*) those curves prepared by the business papers for the general business of the country; (*b*) curves of tonnages made for the principal clients each month for as far back as possible; and (*c*) curves of the monthly output from foundry. From a general survey of the last few years May has been a good month for the London jobbing foundries, whilst October has been poor. Such curves will indicate (*a*) the seasons when special efforts have to be made; (*b*) the type of work of which there is a periodic shortage; and (*c*) the value of leaving a production facility for new customers. Copies of these curves should be made available for the salesmen.

For the foundries making a speciality reasons must be established for the superiority of this production over that of their competitors, and these facts must be drilled into the minds and included in the pocket books of the salesmen.

Finally, we would remind all foundrymen, no matter how small their establishments, that they are *manufacturers and not little tradesmen*, and that their notepaper and business cards should be patterned on the lines of the former and not on the latter. We have noticed during the last few years a considerable improvement in this respect, and we feel that there is still, amongst the smaller establishments, an insufficient realisation of the value of what is after all the first impression one gets of any particular firm.

Oxy-Acetylene as Applied to the Construction of Boilers for Central Heating.

At the November meeting of the British Acetylene and Welding Association, at the Old Colony Club, Aldwych, London, Mr. Samuel Fox, of Messrs. Hartley & Sugden, Limited, of Halifax, read a paper on this subject, in which he first of all recounted how oxy-acetylene welding first came under notice in this country. His own knowledge of it, he said, dated back to the Düsseldorf Exhibition in about 1908, where a member of his firm saw some cylindrical boilers with flanged pieces welded on, and as this particular job had always been looked upon as an impossibility, the foreman welder was sent to Düsseldorf to investigate. This foreman, however, returned very little wiser, and could only report that the pieces were certainly welded on by some secret process which he himself could not fathom. However, the process found its way here eventually, and was being used on a very small scale indeed in the Midlands when there was a strike of fire welders throughout Yorkshire in 1913, which lasted seven months. The result was that several firms installed oxy-acetylene welding, and some of them never re-engaged their fire welders again. That is the history of how gas welding first got a real foot hold into the boiler-making industry. But once there it never went back, but continued to make steady progress, until to-day there is hardly a fire welder in the trade outside London.

The paper described certain classes of war work done by the oxy-acetylene blow pipe, and the author claimed that it has now been proved that the weld is much stronger and more generally satisfactory than the old fire weld, but he added that this is only the case when really skilled men are employed. After the war it was quickly discovered that the so-called gas welder trained during the war to do light work not subject to test pressure, was useless in the trade. Indeed, this particular type of man did the trade much harm because he was generally incompetent.

Speaking of defects with the insurance companies, the author stated that there is now little trouble with them, and that they will pass for insurance a vertical steam boiler oxy-acetylene welded throughout for a working pressure of 25 lbs. per sq. in. Lately, however, there had been a little trouble in Australia, where the law does not allow welding which may be subjected to steam pressure even so low as 15 lbs. per sq. in., but on giving proof that the English insurance companies accepted this class of work the trouble was removed.

Reference was made in the paper to an interesting method for the manufacture of cross tubes for steam boilers working up to 80-100 lbs. per sq. in. The seams are first gas welded and then re-heated and subjected to pressure under a hydraulic roller machine. Gas-welded seams finished in this manner are very difficult to detect, the surface is perfectly smooth and the weld much stronger, so that it has the appearance and almost the strength of a solid drawn tube. The hydraulic machine was worked with about 12 tons in accumulator and the re-heating was done by coal gas. Since 1919 the author stated that he has welded in this manner large quantities of straight seams in cylindrical boilers and cross tubes, and never had a failure.

Previously to the introduction of gas welding many attempts had been made to produce a wrought boiler made in sections, but they were all complete failures when only fire welding was available. Large power sectional boilers, however, are now being made in mild steel, gas welded, and are regarded as being most efficient.

The paper mentioned also that there are many details of fittings which used to be studded or rivetted to boilers which are now welded more efficiently and cheaply. As compared with fire welding also, comment was made upon the great saving in space and capital expenditure.

Finally the author urged the manufacturers of oxy-acetylene welding apparatus and materials to spare no effort to improve them. He asked them never to be persuaded to cheapen their products at the expense of efficiency, because he was convinced that there must be a great future for oxy-acetylene welding, provided the apparatus and materials were constantly improved. Although gas welding had established itself, it had been held back for many years by what might be termed a succession of accidents, and in face of the strongest opposition and prejudice from men who had spent their lives working another process. Moreover, even to-day there was still a considerable amount of prejudice against oxy-acetylene welding on the part of engineers to be overcome.

Discussion.

MR. WALTER YATES (President) said oxy-acetylene welding had been damned time after time as a consequence of the poor workmen employed on it, and the Association should deal with the training of welders. All those who had practised the art had found great difficulties in the matter of expansion and contraction and the subsequent distortion attending upon it.

PROF. F. C. THOMPSON (Manchester University) expressed the view that provided it was done well hammering was undoubtedly an excellent thing, but there was one danger that might sometimes arise. It was probably well known to those present that just below red heat steels enter a brittle range, and, in the case of forging, if the forging treatment was carried on at too low a temperature in order to get a very nice surface on the bar—and the same thing applied to welded work—there was a danger of little hair cracks being developed as the result of the hammering or forging in this brittle range. When the future of welding generally was considered it seemed to him that the first thing the industry as a whole wants is not better plant, not better electrodes, perhaps not even better workmen, but to convince the engineer that welding is good. Everybody knew that to-day welding can be extremely good, but it was useless ignoring the fact that some welding in the past had been as bad as it possibly could. The engineer, naturally enough, asked for something in the way of tests. He knew that if he had bad steel to handle he, at any rate, had a chance of detecting it by ordinary mechanical tests, and what the engineer at the present time was uncertain about was this; he knew that a job in many cases could be welded, but he was not satisfied that the particular piece of welded work offered him was good. In some directions the engineer was more or less helpless because nothing can be done to satisfy him. It was a matter of the greatest difficulty to devise some means whereby the engineer could satisfy himself that a particular piece of welding in which he was interested was satisfactory, but if it could be done it would undoubtedly redound to the enormous profit, both financially and from the point of view of the reputation of the industry. Work of that kind, it seemed to him, could be best done in a more or less co-operative spirit, and if it could be done he was certain there is nothing which would repay the welding industry of this country more than that would.

MR. A. STEPHENSON said that the quality of steel could vary considerably, and he wondered what attention the author had given to that, because no information was given in the paper as to the quality of the particular steel used. The author would help a great deal if he could say what steps had been taken to make sure that, not only was the metal up to specifications in its physical properties, but also that something was known as to its weldability.

A New Method.

MR. C. S. SMITH said it was extremely difficult even now to get good welders, and it was extraordinary how slow progress was, owing to engineers being so reticent in taking up the new process. He had seen recently a very interesting method of welding, using an oxy-acetylene blowpipe, which was something like Mond gas welding. It was a very ingenious blowpipe, held at the end of a long movable rod, which heated the under-side of the weld and also hit the top surface

of the weld by hammering the weld, instead of the usual fusion welding process, and extraordinarily good work was done in making tubes to a very accurate diameter by this process.

B.O.T. Exclusions.

MR. W. C. FREEMAN said the welding industry laboured under a big disadvantage in the Board of Trade Regulations which prohibited the use of oxy-acetylene welders for marine boilers in tension. How long was the industry to labour under the stigma implied by the Board of Trade that boilers in tension cannot be satisfactorily welded by the gas process? He attributed this state of affairs partly to unskilled methods and also to the fact that generators of too low capacity had been employed to give a suitable delivery of acetylene, combined with an element of unskilled labour. Having regard to the author's experience of both gas and electric welding, it would be interesting to know if he had found any such line of demarcation at which oxy-acetylene should be dropped in favour of electric welding, because as broad-minded people they must admit that both systems were good and have their special applications.

Two Welding Associations.

MR. A. E. SHORTER commented on the fact that there are two institutions in connection with the welding industry in this country, namely, the British Acetylene and Welding Association, and the Institution of Welding Engineers. It seemed to him that it was time these two Associations came together and pooled their resources and worked together for the extension of the welding industry in Great Britain.

Hammering Welds.

MR. FOX, replying, said that a man stood by the welder with a light hammer and tapped the weld as the work went along, and it was found that this not only gave a better finish, but made a stronger job. As to the quality of steel, the only steps that could be taken to ensure that the steel is more or less the same every time was to buy from the same rolling mills always. At the same time only about 5 per cent. of his firm's work was hammered. As regards a line of demarcation between electric welding and gas welding, he had no such line as regards the metal, but he had one as regards design. What he meant by that was that occasionally he had a deep flat surface, something like 7 ft. x 5 ft. x ½ in. in thickness, and for that purpose he would use the electric welder because of less distortion. As to costs of gas welding, whilst the costs were taken he had no meters for measuring the quantity of gas used. Indeed, if anybody could give him the name of a perfectly satisfactory meter for that purpose, he would be very pleased to have it. Comparative costs of electric and gas welding showed that for the general class of its work gas welding was cheaper.

Various Causes of Scabs.

BY J. E. P.

While it is of great importance to encourage all who are in any way connected with or interested in the foundry industry to express their views upon any phase of foundry work through the medium of THE FOUNDRY TRADE JOURNAL, it is still more important that in doing so they should remember the journal has attained a very high standard of efficiency in dispensing sound theoretical and practical knowledge of foundry work to its readers throughout the world. It therefore becomes imperative that all who write for publication should at least contribute sound knowledge based upon scientific research or practical experience for the general good of the craft.

In the issue of THE FOUNDRY TRADE JOURNAL of August 19, 1926, Mr. H. S. Newton writes an article on "Scabs: Their Cause and Remedy." It is undoubtedly the writing of a very young man with little knowledge of foundry work, and less experience. However, it is hoped that these remarks will not deter him from pursuing his studies, especially in the direction of scabs and other causes of bad castings. There is so much to learn, and such a vast field for investigation, in this connection.

If it were not fairly certain that he is a young beginner striving after truth and knowledge, and who in the years to come will be a very useful man to the industry, these remarks would not have been written.

Mr. Newton starts off well satisfied with himself and sure of his ground. He says:—"After a considerable time of practical experience, the author proposes to outline a method which will minimise, if not altogether eliminate, bad castings through scabs." What does he think is a considerable time of practical experience—two, three, or five years? After all, moulders of forty and fifty years' practical experience still make defective castings through scabs, and cannot point the way with any certainty to eliminate this fault so as to ensure a continuity of good, sound, scabless castings; most assuredly, to follow Mr. Newton's method would not eliminate this trouble.

Then he says:—"The sand mould is the most pliant body concerned, and it makes room for the gas." What an absurdity. Who ever heard of sand being more pliant than gas?

As to the displaced sand making room for the gas—well, it is just simply an exchange of places; the sand is still there, and so is the gas until it is dispersed by the heat of the metal.

With regard to sand washed away from any part of a mould usually staying immediately opposite where the displacement takes place, loose sand in a mould will float generally to the top of the mould, whether wasted from the mould or dropped in when the mould is being closed. If it does not float, it is usually because of the viscosity of the metal.

One Cause of Scabs.

The late Mr. R. Buchanan held "That dull, sluggish metal was the cause of moulds scabbing," and explains as follows:—"As the first metal enters the mould—being dull—it wants to settle down on the nearest part of the mould, and the other metal coming in wants to push the first lot along, and, as it is partly set, it carries some of the sand under it along, thus causing a scab by disturbing the sand."

Mr. Newton's views on CO and CO_2 were properly corrected in an editorial footnote.

Influence of Pressure.

Mr. Newton tells us the mould itself, if rammed properly, will expand, helping to reduce the "pressure." What pressure is he referring to?

At the time of pouring a mould, there is no expansion of the mould. When the mould is filled with metal it might expand a little, but not appreciably. Certainly, it cannot influence the pressure of gas, as the gas has all gone out as soon as the mould is poured.

Influence of Peg Ramming.

With regard to the peg rammer being kept back from the pattern, Mr. Newton does not say how far back it should be kept, and without this exact information, one, not knowing, may be tempted to keep it back too far. Then the face of the mould would be too soft, resulting in a swelled casting.

The exact safe distance to keep the rammers back from the face of the pattern is 1½ in. for the pegging rammer and 3 in. for the flat or dog rammer.

Influence of Risers.

Risers are not provided for the escape of gas; if a riser is left open, the gas seen coming from it at the time of pouring the mould is being drawn through the sand into the mould, then out of the risers. This may probably disturb the sand on the face of the mould and cause a scab. Risers, if any, should be sealed, and the gas forced through the sand into its proper channels—*i.e.*, the vents.

The susceptibility of a vertical face to scab more than a horizontal face is quite unsound in practice. The horizontal face of a mould is much more likely to scab than the vertical face, simply because the metal dashing upon it has a very marked tendency to tear up the sand upon which it drops, and to prevent this happening, face-sprigging is resorted to—that is, sprigs or nails are placed in the sand face fairly close together—say, ½ in. apart—just where the full force of the liquid metal collides with the sand face of the mould.

In ramming vertical faces of a mould layers of sand are formed in a sense as in all ramming, but certainly not vertical layers. The action of ramming—peg flat and the moulders feet—all have the same downward movement on the sand, thus forming *horizontal* layers, but even then there is no danger of scabbing from them.

There are many more causes of moulds scabbing, although Mr. Newton seems to think there is only one, *i.e.*, confined gas.

Scabs from Dampness.

Damp sand will readily cause a mould to scab; as soon as the liquid metal comes upon that damp sand it rapidly generates steam, so rapidly that any amount of venting on, or in, a perfectly rammed mould, will not allow this steam to escape sufficiently quickly. It will break up the sand of the mould and if violent it will blow the metal out of the risers and runner and keep on blowing until all the liquid metal is blown out, or all the steam has gone off by the drying of the damp place.

There have been some very serious accidents through loam moulds and dry-sand moulds not being properly dried, or in the case of green-sand mould, through some part being too damp.

Certainly there have been some very ugly castings turned out, scabbed all over entirely through dampness in the mould.

The golden rule to follow: *to dry the mould thoroughly!* This, of course, refers to loam and dry-sand moulds. Skin drying is far better left in the hands of the experienced moulder.

Scabs from Poor Sand Mixing.

Badly mixed facing sand will cause scabs. Should there be in any locality an excess of coal dust it will be converted into gas as soon as the liquid metal is poured upon it, and this will go on until all the coal dust is burnt up. Then the sand becomes so friable that it is easily washed away. An excess of clay in the facing sand will also cause scabs; the reason is quite obvious.

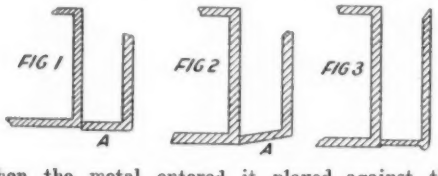
Sleeking as a Cause.

Entensive sleeking the face of the mould will cause scabs. This sleeking closes the pores of the sand, making it rather on the hard side, so that the metal will not lay quietly upon, or up against it but commences to dance and splutter and bubble until it tears and disturbs the sand.

Facing sand mixed too dry will wash away under the flow of the metal, causing scabs.

Badly placed runners and those too large, will sometimes cause a mould to scab. If the liquid metal does not get a free flow into the mould it will cause scabs. It has been known for the cod of a large mould to be almost washed to pieces by the metal impinging upon it, when it ought to have had a clear straight and free run.

Fig. 1 is an example of badly placed runners. It will be seen that the gate A is too low, so that



when the metal entered it played against the edge of the mould which formed a kind of break to the flow of metal, which put undue force upon that point, so much so, that it washed the sand away and scabbed nearly the entire face of the mould.

Fig. 2 shows another badly placed runner which caused scabbing. It will be seen that the gate A is pointing down, which directs the flow of metal on to the bottom.

Fig. 3 shows the correct method by this, the metal flows easily into the mould without obstructions of any kind.

Generally speaking the size, shape and position of runners is left to the discretion of the moulder to determine, a phase of foundry work at which most moulders excel.

The size of the gate determines the rate of filling the mould, so it becomes increasingly important that more thought and study should be given to this question.

If runners are too small, the mould is so long in filling that sometimes the top part is drawn down. This is an aggravated form of scab. If the runner is too large the metal will rush into the mould in a wild torrent, tearing and washing the sand away, another scab.

Catalogues Received.

Tool Steels.—Sir W. G. Armstrong, Whitworth & Company, Limited, of Openshaw, Manchester, in their new catalogue on tool steels, maintain the high standard which one always associates with their publicity matter. We specially advise foundrymen to procure a copy of this, as they have need for many varieties of tool steel for the complete performance of their work. Like foundrymen, the tool-steel maker has many brands, and in this brochure some 20-odd are listed, but these are only standard lines capable of an infinite expansion for industrial needs. The book has 58 pages, is excellently illustrated, and jacketed in slate blue stiff paper backs.

Die-Casting Plant.—An extensive range of die-casting plant is described and illustrated in an 18-page catalogue just issued by the Monometer Company, of Savoy House, Strand, London, W.C.2. For general die-casting work—if such a thing exists—the Simplex presents many desirable features, but the firm realising the complexity of the problem have special models for special purposes. For instance, a machine has been designed to work a patented process for railway axle-box housings. For white metal work a furnace provided with a mixer has been designed. Paraffin oil-fired melting furnaces are still another speciality illustrated. Gravity die-casting also receives attention, and a furnace has been prepared for this field which incorporates several innovations. It is a catalogue which will be valued by most foundrymen.

Book Review.

Deutsch-Englisches und Englisch-Deutsches Fachwörterbuch für das Giessereiwesen. Published by the Verein duetscher Eisengiessereien, Giessereiverband. — Düsseldorf, Giessereiverband, Breitestrasse 29. (Price for members of the Society, 2.50 mks.; non-members, 3 mks.)

This little German-English and English-German dictionary of foundry terms has been compiled for the benefit of German foundrymen who accepted the invitation of the American Foundrymen's Association and visited the special international foundry exhibition at Detroit; and also for the use of their numerous colleagues who may wish to visit English-speaking countries. It is, according to the foreword, the first attempt to gather together foundry terms and their equivalents in the other of the two languages named on the title page. It is not quite clear why it is claimed to be the first attempt in this respect, as the compilers are aware of the existence of the Schlomann-Oldenbourg series of illustrated technical dictionaries in six languages, and have no fault to find with the completeness of the part dedicated to foundry matters, the only objection to the volume containing this being that it is too bulky for use as a travellers' guide. It must be admitted that in this respect the present thin volume, extending to 60 pages only, will not take up quite so much room in the pocket. There are some mistranslations (as, for instance, "soldering" = "Schweissung," which elsewhere is rendered correctly as "welding"), mis-spellings ("feddling" instead of "fettling"), misprints (soaking "kit" instead of "pit"), etc. A little more attention to the Schlomann dictionary would also have prompted the use of more familiar terms, as, for instance, crab (instead of crane runner). There are some blunders like "Thomasschlacke," which is, of course, basic and not acid slag, and "Tannenholz," which is, of course, fir and not hemlock.

THE NEXT ANNUAL CONGRESS of the Association Technique de Fonderie de Belgique is to take place in Brussels on March 19 and 20, 1927, under the presidency of Mr. Paul Ropy.

Some Grey Iron Problems.*

By John Shaw, Sheffield.

[BRITISH EXCHANGE PAPER.]

(*Continued from page* 430.)

[ABSTRACT.]

Discussion of Third View of Loss of Chill Between Test Bars and Rolls.

The third view regarding the cause of loss of chill between the test and the roll, is that manganese, under certain conditions acts as a softener, not only by its action on the sulphur, but by its direct graphitising effect on the carbon.

It may be taken for granted that Si and Mn are similar in their neutralising of the carbide-forming effect of S. Both are hardeners of cast iron by their direct action, and both elements have a softening effect on cast iron due to their indirect action on the carbon.

Outerbridge, Jr., suggests that the softening effect of Mn is lost when high C, high Si (with its low S) are present in the material. He states it often leads to hard spots. Coe is in agreement with this idea, "It appears that a quantity of manganese as low as 0.18 per cent. (with no S present) is able to produce a great change in the composition of the iron; more than about 0.5 per cent. Mn tends to retain more carbon in the combined form." Now all these statements, while true for the conditions worked under, do not hold good for different conditions. For instance, earlier in the same paper Coe states when using a Blaenavon hematite and casting ¾-in. square bars from it, "It will be seen from the analyses that the addition of 2 per cent. Mn to such an iron produces an inappreciable chemical effect, in fact, it appears that with 2.65 per cent. Mn there is a softening action owing to a decreased percentage of combined carbon." Low C, low Si, and high S would all demand higher Mn to obtain the same softening effect on irons of contrary composition. This factor may perhaps reconcile some of the divergent views held on this question.

What proofs can be offered? Outerbridge, Jr., in a paper* before this association, found that the addition of roughly 0.14 per cent. manganese to a ladle of metal reduced the chill. The combined carbon was reduced to about one-half of that in the receiving ladle. "Manganese," he mentioned, "is commonly supposed to exert a hardening effect on cast iron, but experience has taught me to regard this as another mistaken notion." The reaction mentioned above is regarded in some quarters as due to deoxidation, but when it is remembered that the car wheel specification calls for a manganese content of not less than 3 to 1 of sulphur in the finished product, it would be thought there was enough surplus manganese present to do all deoxidation needed in the cupola or at least in the large receiving ladle, long before this small addition of manganese was made in the 600-lb. ladle. If one will consider this as an addition of softening material the result is clear at once.

Coe's experiments were conducted under laboratory conditions, so oxidation would be taken care of. As in his grey iron material sulphur was below 0.03 per cent. and below 0.01 per cent. in his phosphoric iron, the question of the effect on the sulphur would not enter into the results to any extent. Two of his results have been quoted. During the preparation of a paper on "Silicon in Cast Iron" by Hague and Turner, the authors found that an arrest point, previously noted in a prior investigation, had disappeared while using their present iron. The only difference approximately being an 0.5 per cent. Mn, it was resolved to make this addition and try the result out. It was found this reduced the combined carbon from 0.84 per cent. to 0.22 per cent. The two analyses were those given in Table VII.

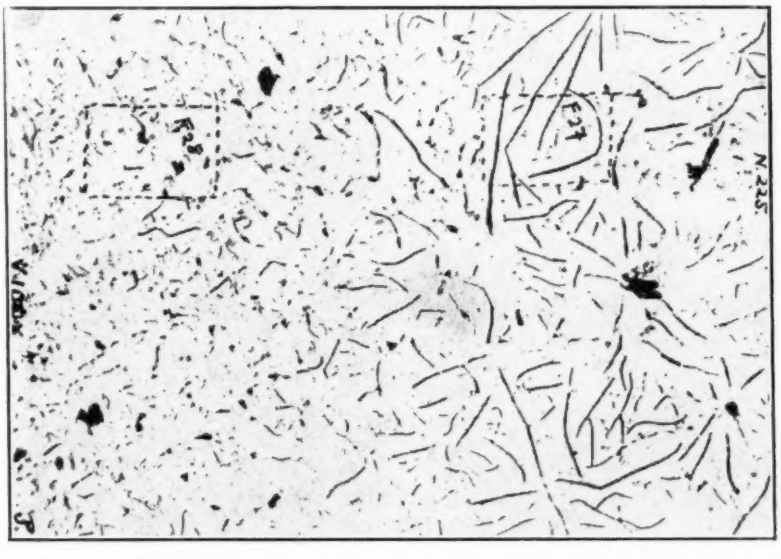


FIG. 26.—D BAR—HIGH SULPHUR IRON—UNETCHED × 100 (PRIMROSE).

TABLE VII.

	Original metal.	Plus 0.5 per cent. Mn.
T.C. per cent.	2.77	2.62
G.C. per cent.	1.93	2.40
C.C. per cent.	0.84	0.22
Si.	3.06	3.00
Mn. per cent.	Nil	0.5
S.	Trace	Trace
P.	Trace	Trace

In Turner's words, "It was seen that there is a considerable expansion corresponding to the arrest point A_2, while the temperature of this arrest is lowered from 764 deg. C. to 687 deg. C." Hague suggests a possible explanation of this expansion, that "it is caused by the separation of, a second quantity of graphite, that from the saturated martensite. In view of the fact that the sulphur is only a trace, it is interesting to record this direct stable graphitising forming tendency

* Outerbridge, Jr., A.E., "Manganese and Silicon in the Foundry," Trans. American Foundrymen's Association, vol. 20, 1911, pp. 17-34.

of the manganese." He also states that "it is only in conjunction with silicon that manganese has this influence."

Personal interest was roused in this subject by noting the combined carbon content in certain rolls not widely varying in analysis, and also to the fact that a combined carbon content round

Fig. 27.—D Bar—High Sulphur Iron—Alcohol Etch—× 100 (Primrose).

the pearlitic point gave a better wearing surface. On reference to the experiment carried out with the 12-in. square blocks it will be seen the analyses of two rolls that are fairly divergent. In so doing differences are most easily seen. The composition of roll No. 2 was aimed at because a hard face was of more importance than strength. Note the combined carbon content and account for its difference

Fig. 29.—K Bar—High Sulphur Iron—Unetched—× 100 (Primrose).

by any other reason than the ratio of manganese to sulphur. There is little doubt in the author's mind that the excess manganese over that necessary to counteract the influence of the sulphur present (whether this is in the form of MnS or $Fe_2Mn_2S_5$, or simply a mixed sulphide, is immaterial for the time). With total carbon 2.96 per cent., Si 0.5 per cent., there is a combined carbon of 0.5 per cent.; yet with the higher T.C. of 3.16 per cent. and Si of 0.83 per cent. the C.C. is 1.37 per cent. Take twenty rolls haphazard whose composition is much nearer, ten with combined carbon below 1 per cent., and ten with combined carbon over 1 per cent., the average of the first ten worked out as in the first column and the second ten averaged as column No. 2 in Table VIII.

These results can be duplicated by reference to the laboratory records. That the results justify the contention, the two microphotographs (Figs.

Fig. 28.—D Bar—High Sulphur Iron—Alcohol Etch—× 100 (Primrose).

31 and 32) taken from the centre of a 33-in. dia. roll weighing 9 tons will show.

Effect of the Ratio of C to Si on the Structure.

The effect of the ratio of carbon to silicon on structure as judged by the chill test is to be considered. The influence of both Si and C has been so fully investigated by Turner, Wüst, Gonter-

Fig. 30.—K Bar—High Sulphur Iron—Etched—× 500 (Primrose).

mann and others, that their effect is well known. What is to be deprecated is the attempt made to apply their conclusions, without due attention to the equally dominating factors of moderate amounts of Mn, S and P in cast iron.

The use that is constantly being made of considering complex cast iron simply as a certain percentage carbon steel interspersed with free graphite, can only lead to wrong conclusions. It is not proposed to discuss this question, but to point out another factor that calls for consideration, that of the grouping together of the total

carbon plus silicon content as contained in some Papers. From it the ordinary man would judge that if T.C. + Si = 5, a similar structure would

TABLE VIII.—*Comparison of Analysis of Rolls: Group* 1, *with Combined Carbon below* 1 *per cent.; Group* 2, *Combined Carbon above* 1 *per cent.*

	No. 1.	No. 2.
T.C.	3.01	3.167
C.C.	0.81	1.32
Si.	0.62	0.79
Mn.	0.426	0.381
S.	0.128	0.162
Ratio	3.3 Mn. to 1 S.	2.09 Mn. to 1 S.

be obtained if the mixture (other constituents being equal) was either T.C. 4 per cent. + Si 1 per cent. or T.C. 1 per cent. + Si 4 per cent. We have found, to our cost, that this is not so,

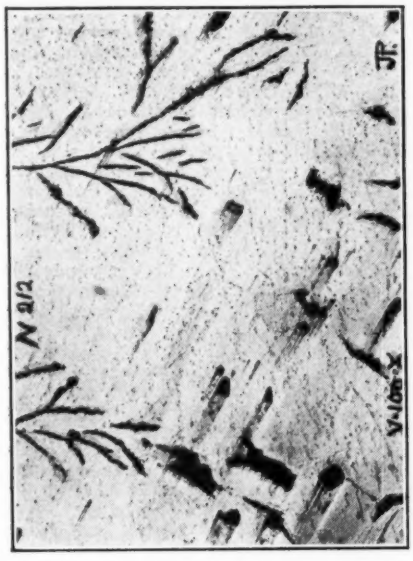


FIG. 31.—33-IN. DIA. ROLL 9 TONS—CENTRE OF ROLL—TWO TYPES OF GRAPHITE—UNETCHED—×50 (PRIMROSE).

and it is not till one is tied down to the fine limits imposed by chill that it is appreciated.

Thrasher, in a Paper on malleable*, put forward the following ratio—that "four points of C are equal in effect to three points of Si, when the Si in the mixture is over 0.7 per cent.; and that below this Si content, two points of C are equivalent to one point of Si in their effect on the structure of the iron" (Fig. 33). Personal experience over several years supports these figures, and

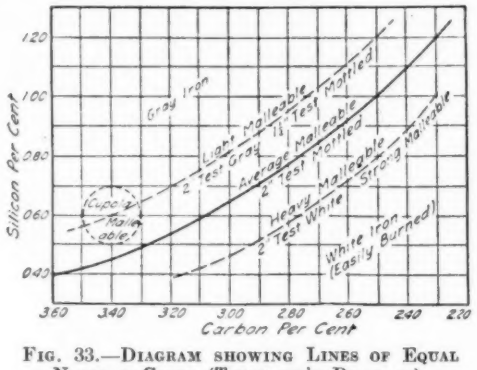


FIG. 33.—DIAGRAM SHOWING LINES OF EQUAL NATURAL CHILL (THRASHER'S DIAGRAM).

further confirmation is to be found on referring to Fig. 5 of Lowry's Paper† before A.F.A. in 1924. Taking the curve of the ½-in. chill, the lower end shows 3.67 per cent. T.C. + 0.4 per cent. Si, the upper end 3.04 per cent. T.C. + 0.75 per cent. Si, the difference being as 35 is to 63, or about twice. The ¼-in. chill curve with its higher Si works out at 51 to 68, or nearly again Thrasher's figure of four points C equivalent to three points Si.

It may be thought that a chill test, while needful for chilled work, does not find a place in ordinary grey-iron practice. For a number of years the author has used nothing else, except a direct impact test. Whilst cast test bars are cast for our customers every week, there is none cast for ourselves to check this work, yet we have only had two failures during the past two years, and both these would pass the A.F.A. specification. We quite appreciate the value of test bars, but unfortunately their results are not known till after the mould is cast. By using the chill test we have a good idea of the ultimate structure of the metal before casting. For instance, we know that, quite irrespective of composition, if the chill test shows

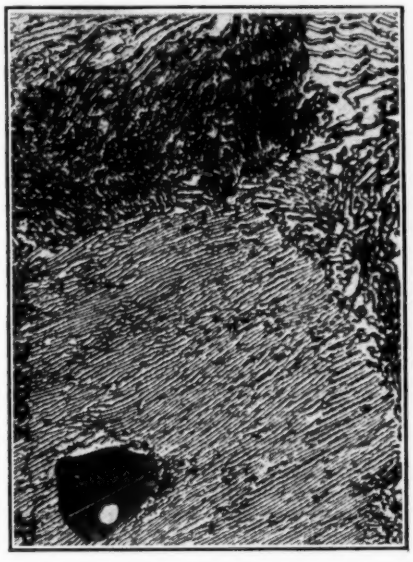


FIG. 32.—33-IN. DIAMETER ROLL, 9 TONS—CENTRE OF ROLL—VARIOUSLY ORIENTED PEARLITE AND SULPHIDE—ETCHED—×500 (PRIMROSE).

⅛ in. to ¼ in. on the 1¼ in. chill test, castings ¾ in. to 1 in. thick will machine readily, and the 1.2 in. diameter bar will easily pass the specification and yield at least 10 tons per sq. in. tensile. For castings averaging 1½ in. thick a test of ½ in. to ¾ in. deep is required, and for cylinders 3 in.

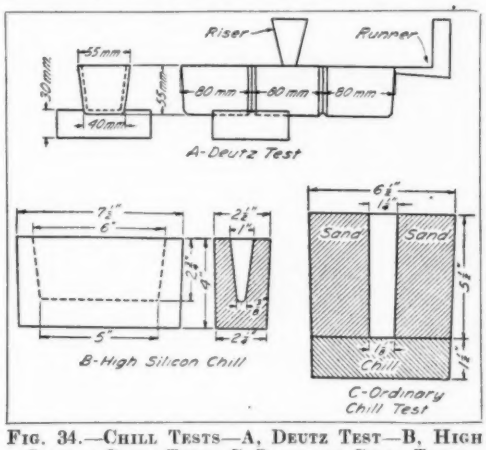


FIG. 34.—CHILL TESTS—A, DEUTZ TEST—B, HIGH SILICON CHILL TEST—C, ORDINARY CHILL TEST.

thick a chill test of 1½ in. to 1¾ in. is required. When one is asked for the higher tests, say 14 to 18 tons tensile, composition is vital and demands low C, Si and P. For silicons 2 per cent. and over, the 1¼ inch thick test is useless, the depth of chill being only about 1-16 in. or less in all cases, so a wedge test was used. This consists of a complete chill with a taper slot 6 in. long by 1 in. at the

* Foundry, December, 1915.
† Lowry, E. J., *The Effect of Chill on Cast Iron*, Trans. American Foundrymen's Association, vol. 32, Part 1, p. 551, 1925.

top, to ¼ in. wide at the bottom, the depth being 2¾ in. A sketch of this is given in Fig. 34B. To use it the chill is slightly warmed, and when the ladle is nearly full a test is cast from a pot ladle dipped into the metal. At the end of one minute the chill is turned over, the tests drop out, and it is dipped into water and broken. The depth of chill is registered from the ¼ in. end. Data from this source correlated to the machining speeds in the machine shop can soon be built up. This information can be used if ever there is doubt about the metal before the castings are run. A third test in daily use was given to the author by the courtesy of the technical director of the Deutz Gas Engine Company, Cologne. It consists of a combination chill and segregation test. The test bar is divided into three pieces as shown by the notches, and a chill is placed from one end to the middle as shown in the sketch, Fig. 34 A. Besides giving the depth of chill and therefore some idea of the ultimate structure by its quicker cooling, any sign of segregation is shown in the more slowly cooled half. This test is cast from the main ladle, left to cool till morning, and broken in three pieces through the notches. The centre piece is then taken into the foundry manager's office, and he can see at a glance from the depth of chill if the hardness of the metal is suitable for the job, and also if there is any tendency for segregation, which would show up at the grey end.

In conclusion, the author wishes to thank Mr. Fred. Firth for permission to publish the figures; his assistants, Messrs. Green and Roxburgh; Mr. J. S. Glen Primrose and Mr. J. G. Pearce for the micrographs; and Mr. J. Ferdinand Kayser, Mr. J. E. Fletcher and Mr. J. H. S. Dickinson for independent tests.

APPENDIX.

Photo-micrographs Figs. 26 to 32 by Glen Primrose.

Fig. 26. Photo-micrograph of bar D, high sulphur iron, unetched, mag. 100 diam.

Remarks.—The main thing to note is the great segregation of graphite. This section is taken near the core and shows the effect of the inverse cooling rate due to the sulphur. At the top the graphite is quite normal sized for this size of casting, but the lower portion contains much more sulphide and the graphite is correspondingly smaller in size.

Fig. 27. Photo-micrograph of bar D, high sulphur iron, etched picric acid, mag. 500 diam.

Remarks.—This shows the part of Fig. 26 near the top at a higher magnification to show clearly the large size of graphite flakes and the small distribution of sulphide throughout the pearlite matrix.

Fig. 28.—Photo-micrograph of bar D high sulphur iron, etched picric acid, mag. 500 diam.

Remarks.—This is from the lower portion of Fig. 26 at higher magnification, and shows the very much smaller size of the graphite flakes, and the increased amount of sulphide segregation throughout the pearlite matrix. Even the pearlite grain size is smaller than in Fig. 27.

Fig. 29. Photo-micrograph of bar K, high sulphur iron, unetched, mag. 100 diam.

Remarks.—There is very much more uniform distribution of graphite in this than bar. D. The low power shows this in contrast to Fig. 26, and also indicates the very striking nest of sulphides present at the centre of the bar shown. There are many places where no sulphide shows at all.

Fig. 30. Photo-micrograph of bar K, high sulphur iron. Etched picric acid, mag. 500 diam.

Remarks.—Same spot at Fig. 29, but at higher magnification to show the small graphite flakes, and also how the sulphides present have globularised. This is typical of MnS, and there is no trace of FeS that could be seen after a long search. The etching with picric acid was selected as it shows up the greatest possible difference between MnS and FeS if there is any, as the latter darkens much more.

Fig. 31. Photo-micrograph of 9 ton roll, near centre of 33 in. diam. Unetched, mag. 50 diam.

Remarks.—This low power clearly shows the two different forms of graphite which have separated in the pearlite matrix. The short stubby voids, and the long, branching flakes, the former near the greatest sulphide separation, and the latter where there is no MnS.

Fig. 32. Photo-micrograph of 9 ton roll, near centre of 33 in. diam. Etched picric acid, mag. 500 diam.

Remarks.—This higher power reveals the completely pearlitic nature of the matrix, and shows one of the sulphide patches which is typical of MnS. The persistence of the pearlite in spite of the slow cooling at the centre of the mass is no doubt accounted for by the 0.2 per cent. Cr present assisting the low Si content.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Foundry Facings.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—We have noted in your paper several articles from contributors, particularly Messrs. Phillips & Grundy, of the Metropolitan-Vickers Company, Limited, Manchester, on refractories as used in the foundry, and are much interested. It is obvious that they speak with a knowledge obtained from practical experience in this particular branch of the industry.

In these circumstances it would be interesting to hear their views on facings composed of other than pure plumbago, that is to say, on mixtures composed of materials of different origins. Under this heading would, of course, be included blackings of many different compositions.

For a great number of years we have supplied to foundries plumbago ground from one origin material, and in our estimation—taking into consideration the characteristics and analysis of the plumbago, and particular method employed in its use—this cannot be bettered. We have examined and analysed several samples submitted to us by our customers, and find that these materials are very low in carbon content, and apparently contain only a small percentage of pure plumbago; in addition, they are very coarsely ground.

These samples, we are told, are used in both the wet and dry state on moulds, and we are surprised to learn they are giving every satisfaction in use. Perhaps your contributors can tell why such a material, so low in actual graphitic carbon, can give satisfaction, as the mixture is not wholly composed of refractories, containing in many cases such materials as china clay, ground coal, coke, etc.

The proportion of the various materials is approximately constant in the samples examined, and from a visual point of view they are almost identical. We shall be glad to hear the opinion of your readers upon this subject, comparing the practical advantages of these types of facing.—Yours, etc.,

"COMPARISON."

[Founders understand quite well that certain grades of facings contain clay, which gives the material "stickiness." Some of the merchants and manufacturers sell their material to specifications laid down by the foundries, wherein such factors as clay content is appreciated as a constituent and not as an impurity.—EDITOR.]

Mica-Schist.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—We have read with interest the paragraph *re* above by your special correspondent, and would refer the so-called "refractory member," who openly confesses he has not heard of this particular material hitherto as a refractory, to page 419 of Vol. XXI of THE FOUNDRY TRADE JOURNAL, which gives in abstract a Paper by Dr. P. G. H. Boswell on "Mica-Schist for Lining Cupola and Steel Converters."

Mica-schist is thus not by any means a "new refractory," and in the early part of last year we had a parcel over from the States for experimental purposes, but were not impressed with it, a view subsequently confirmed on close inspection of cupolas patched with it in America.—Yours, etc.,

Per pro THOMAS E. GRAY & COMPANY, LIMITED,
T. H. GRAY.

119, High Holborn, London, W.C.1.
November 22, 1926.

WALTER DIXON & COMPANY intimate that the practice of consulting engineers carried on by them with the late Mr. W. Dixon and Mr. F. Anslow as principals is being continued under the name of Walter Dixon & Company, the partners being Mr. F. Anslow and Mr. A. Dixon, son of the late Mr. W. Dixon.

The Firth Hardometer.

Progressive foundries are realising that the increasing call for a fuller knowledge of the physical characteristics of materials necessitates the installation of various forms of testing apparatus in their works. To many such firms the equipment of a testing department, embodying even a few of the resources of a research laboratory, is a problem practically insurmountable on account of the cost.

The "Firth Hardometer," however, presents a simple unit of testing equipment which, for a reasonable cost, covers a wide range of hardness testing requirements.

Design Considerations.

The design of this machine represents much accumulated experience in the use of such apparatus, and especial regard has been given to simplicity of operation and robustness of construction in order that it may be operated, after but a minimum of tuition, by semi-skilled hands in practically any part of the workshop.

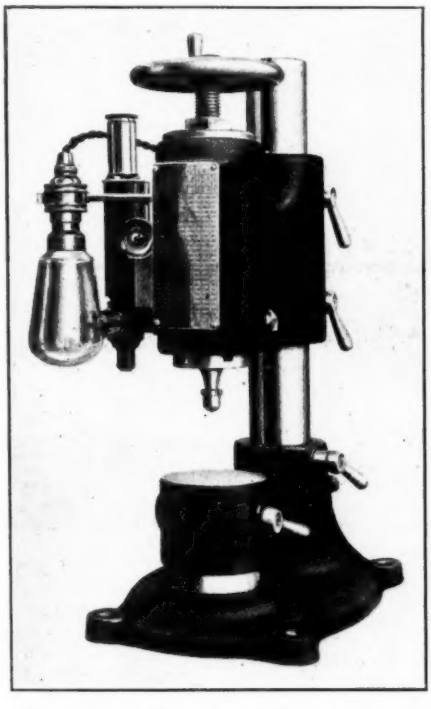


FIG. 1.—FIRTH HARDOMETER IN POSITION FOR TAKING TESTS.

The "Firth Hardometer" has the advantage of eliminating the effect of inertia when applying the load, and thus rules out that very considerable source of error to which many machines of this type are prone, especially when making an impression of so small a dimension.

Construction.

Figs. 1 to 3 indicate the general lines on which the new machine is constructed, and it will be observed that the machine is provided with a sliding head which is readily adjusted to take materials of different sizes. The adjustable anvil permits of irregular-shaped articles being tested. The load is applied through a specially calibrated spring and trip mechanism, and in such a manner that only the exact load can be applied. The whole of the mechanism is entirely enclosed and protected. The machine may be supplied alternatively—(1) with 120-kg. load cylinder and 1-in. microscope objective for testing medium and hard steels down to 1 mm. thick, and soft metals down to 2 mm. thick, which covers all ordinary testing purposes; or (2) with 30 kg. load cylinder and ½-in. microscope objective for testing cast iron or medium and hard steels down to below ½ mm. thick or soft metals down to 1 mm. thick. No. 1 method is the most suitable for workshop use, and is preferable where only the thicker range of materials require to be tested; No. 2 method being a special-purpose alternative or for scientific research work. With the addition of a special diamond indenter the machine in either form will test the hardest of hardened steels.

With every machine is supplied a specially-designed microscope of high magnification, permitting the rapid and reliable measurement of impressions; a standard hardness check test piece, the necessary ball-retaining caps, hardness numeral tables, two dozen spare balls, a waterproof cover, and a book of instructions. The diamond and tables appertaining thereto are supplied as an extra. The machine may be supplied with whichever load cylinder and objective is preferred.

The Diamond Indenter.

It is recognised that in testing the hardness of steel the use of the hardened steel Brinell ball is limited. Materials exceeding 600 on the Brinell scale tend to deform the ball, and there is very little discrimination in the hardness values above this range. Moreover, owing to unavoidable variations in the quality of the balls used for test, the results obtained on hard samples are frequently inconsistent as well as misleading as to relative values. To avoid such unsatisfactory conditions the tool used for making the "indentation" should substantially exceed the hardness of the sample to be tested.

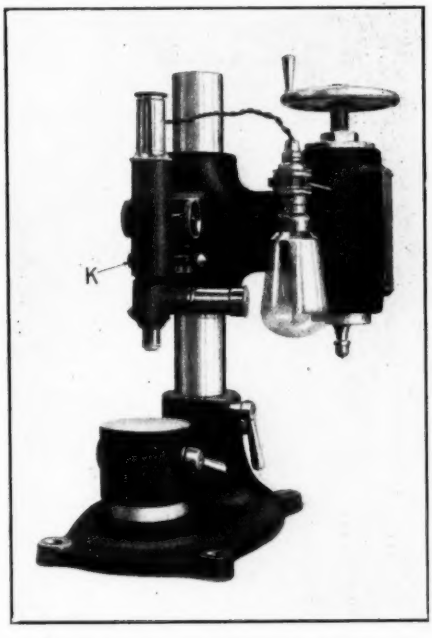


FIG. 2.—FIRTH HARDOMETER ARRANGED FOR READING THE RESULTS.

It is now recognised that the best method of testing hardened steel of over 600 Brinell is to use a diamond. Thus there has been incorporated for use with the "Hardometer," diamond "indenters" which can be used in this machine by merely changing the ball for such an indenter. This change can be readily effected, and a suitable adapter is supplied with each diamond.

Diamond points—that is, diamonds of specially selected quality, cut and polished and set in a special holder—besides being very accurately made, are robustly mounted and are quite suitable for workshop use. By including one of these in the equipment the machine is then available for testing specimens up to the hardest high speed or other tool steel, and will be found of exceptional value for the use of the inspection departments of motor-car and other works, where it is the practice to work to a standard of hardness for the hardened parts. It is advisable that the hardness numbers obtained when using the diamond indenter should be referred to as "Diamond Hardness Numbers" to distinguish them from the Brinell numbers obtained by the usual method with a steel ball.

A Comparison of Whiteheart and Blackheart Malleable Cast Irons.*

By A. E. Peace.

Introduction.

The history of malleable cast iron commenced about 200 years ago when the Frenchman, Reaumur, made what is now known as whiteheart malleable cast iron. At that period there were only three kinds of iron known; these were wrought iron and cast iron—obtained by reduction of the ore—and blister or cementation steel obtained by heating wrought iron in charcoal. It seems probable that this cementation process was the germ of the idea of making malleable cast iron by substituting ore for the charcoal and thus removing carbon instead of adding it; this sprung up into an industry in Europe, the manufacture chiefly being confined to harness parts, nails, and similar small work. About 100 years later an attempt was made in America to produce malleable cast iron by this process. Boyden, in Newark, U.S.A., spent some years trying to make malleable cast iron, and was rewarded with success; but the fracture of his iron was blackheart instead of whiteheart. This was due to the different composition of the American pig-irons. The European irons were chiefly low manganese and high sulphur, whereas the American irons were the reverse; and thus, in addition to removing carbon by the action of the ore, graphitisation took place, producing the black fracture. It is thus seen that the two types sprung from the same idea and were at one time made by the same process, but owed their individuality to the difference in the local pig-irons. It is only comparatively recently that packing the castings with ore has been abandoned in the blackheart industry, thereby emphasising the metallurgical difference of the two products.

Method of Manufacture.

Pig-iron and scrap are melted to give an iron which when cast in sand moulds shall be free from graphite, *i.e.*, a white iron. The production of castings free from primary graphite is essential in making malleable cast iron, as during the annealing process any graphite flakes are subject to growth which so weakens the iron that in bad cases the metal is more brittle than ordinary grey cast iron. The white iron castings are subjected to annealing at a high temperature for some days with or without a hematite ore packing, when the product is rendered malleable.

Chemical Composition.

The essential difference in the two materials is due to the pig-iron used. The whiteheart industry uses white and mottled hematite, the compositions of which are not standard except in respect of phosphorus content, which is always low. The carbon, silicon, manganese and sulphur all vary within fairly wide limits, and this is probably the greatest difficulty the whiteheart manufacturer has to face. The carbon varies from 3.0 to 3.6 per cent., the silicon from 0.3 to 1.0 per cent., the manganese from 0.05 to 0.60 per cent., the sulphur from 0.15 to 0.40 per cent., and the phosphorus 0.08 per cent. and less. These figures do not cover all the pig-irons used in whiteheart manufacture, as some special refined irons of low sulphur and low carbon content are on the market, but the irons indicated form the basis of the whiteheart mixtures. The blackheart iron is made from grey hematites differing chiefly in their higher manganese content, which is 0.50 to 1.00 per cent., and low sulphur, which is usually not above 0.06 per cent. The silicon in these irons is generally higher, particularly where the melting medium provides a means of oxidation.

* A Paper read before the East Midlands Branch of the Institute of British Foundrymen, Mr. E. Stevenson presiding. The author is on the staff of Messrs. Leys, Limited, of Derby.

Melting and Casting.

Whiteheart is chiefly made from the cupola, though crucible melting is still practised. Blackheart is rarely cast from cupolas owing to the increase in sulphur obtained and to the higher carbon content of cupola metal. Air furnace, open-hearth, crucible, electric furnace, and a combination of the electric furnace cupola and Bessemer converter are all used, but the most popular melting medium is the air-furnace. It will be readily understood that the melting of iron for the blackheart industry is considerably more expensive than for whiteheart. This fact tends to make the economical production of blackheart only possible when conducted on a comparatively large scale.

The only similarity between the hard iron before annealing is that it is in each case white fractured. The blackheart is lower in carbon than whiteheart, and consequently is stronger, less brittle, and not so hard in the unannealed state. Whiteheart, before annealing, contains from 3.0 per cent. to 3.5 per cent. of carbon, and blackheart from 2.3 to 2.8 per cent. In both cases the carbon is in the combined form. The structure of the irons both consist of pearlite and free cementite, but there is considerably more of the latter in the whiteheart than in the blackheart, which accounts for the difference in strength. The structural composition of whiteheart as cast is pearlite 60 per cent., and free cementite 40 per cent., whilst blackheart is pearlite 75 per cent. and free cementite 25 per cent.

Blackheart is usually cast at a higher temperature than whiteheart, this being necessitated by the higher freezing point of the iron, which involves a much higher temperature to get sufficient superheat to give the metal "long life" and fluidity. The usual melting furnaces employed in blackheart manufacture permit of higher casting temperatures than are common with the cupola.

Casting in both industries is usually done by hand or shank ladles, direct casting without transferring from a large ladle to a small one is the general rule, but in blackheart foundries using air-furnaces, open-hearth, or electric furnaces pouring very hot metal the iron is frequently carried in large ladles to the moulder's side. Crane ladles are in use, and a one-ton bottom pouring ladle is in use in at least one blackheart plant in this country.

The methods of moulding are similar, both irons possessing great liquid shrinkage and high contraction; the feeding and gating difficulties are common to both processes. The linear contraction of both irons is approximately $\frac{1}{4}$ in. per foot, but as there is about $\frac{1}{16}$ in. per foot for expansion on annealing, patterns are made to $\frac{5}{16}$ in. contraction.

Blackheart possesses a certain advantage in casting in that, as just mentioned, the furnaces used permit of obtaining longer life and greater fluidity than does the cupola.

Whiteheart castings in the hard state require more careful handling than blackheart on account of their greater brittleness. A certain amount of fettling is done on blackheart castings in the hard state, as they are strong enough to permit of knocking off flash without cracking.

Barrelling is largely used for removing sand before annealing in the case of blackheart, but this is generally too severe a treatment for anything but small castings in whiteheart, and sand blasting is generally adopted. The castings are, of course, inspected before going into the annealing ovens.

Annealing.

The great difference in annealing is due to the fact that all the carbide of iron in blackheart is decomposed by heat, but that the carbide in whiteheart is stabilised by the high sulphur content, and only yields slightly to heat treatment. In

whiteheart red and black iron ores are used to provide oxygen for removing the greater part of the carbon.

Blackheart castings are packed in sand, slag, gravel or mill scale. This is done to prevent distortion during annealing. Blackheart anneals quite satisfactorily, however, without any packing medium. The annealing is carried out at 800 to 880 deg. C. for a period of from 2½ to 3½ days. Whiteheart castings require a higher temperature and a longer period, and are annealed at 900 to 1,000 deg. C. for 3 to 4 days. These times cover only the period at the annealing temperature. The time taken for heating up and cooling down depends on the size of the oven, amongst other things, and makes the total cycle in both processes from 8 to 14 days. Slow cooling is necessary to obtain the best results, and that malleable made on a short annealing cycle is generally inferior. To obtain perfect results with whiteheart necessitates slightly different treatment for castings of different section, the annealing under standard conditions being less and less complete as the cross section increases. The section which can be satisfactorily annealed in whiteheart is therefore limited by the depth to which decarburisation can be commercially effected. This limit is somewhere in the region of ¾ in. The section which can be made in blackheart, on the other hand, is limited not by the annealing process, but by the section above, which it is impossible to cast without getting primary graphite. This limit is somewhere around 3 in.

The cost of annealing is much higher in the case of whiteheart than blackheart. The use of ore and the greater time taken in packing the castings add to the expense. It is usual in the whiteheart trade to surround each casting with hematite ore, whereas in blackheart the packing material fills up the spaces left after the castings are placed as closely together as is possible. Thus a greater tonnage of blackheart can be packed in a certain space.

The chief item in the difference in annealing expenditure is fuel. From one to two tons of coal are required to anneal one ton of whiteheart malleable, but only ½ to ¾ ton will anneal a ton of blackheart castings. Owing to the higher temperature in the whiteheart anneal, the pans do not last so long. The pans used in both processes are usually made of a white hematite iron, the same type of pig-iron which is used for making the whiteheart castings being very satisfactory. The use of nickel chromium alloy pots has been tried out, but reducing atmospheres and the sulphur gases from the coal prevent them giving the life which one would expect from them, and in any case the initial cost is prohibitive. For example, the cost of equipping the plant with which the author is associated with nickel chromium alloy pans would be something like £100,000. The ordinary white hematite iron pans last from three to six anneals with whiteheart and about eight with blackheart.

Blackheart plants usually operate on a larger scale than the majority of whiteheart foundries, and as a consequence the annealing ovens are larger. From 10 to 30 tons capacity is common in the blackheart trade, whilst 4 to 10 tons is usual in whiteheart foundries.

After annealing, barrelling is often resorted to in order to remove any adhering packing material. This also gives a good surface to the castings, which is appreciated by a great many consumers. Grinding and chipping is adopted in both industries for fettling.

Straightening.

Present-day rapid machining methods call for accurate castings which can be set up in jigs. As the annealing process introduces distortion, due frequently to the irregular expansion of intricate castings and to sagging of the pots, it is necessary to straighten and set a large number of castings. Whiteheart malleable being annealed at a higher temperature, is subject to rather more distortion than blackheart. General practice is to set the castings hot, though there is a tendency to-day in both whiteheart and blackheart foundries to adopt cold setting wherever possible. Cold straightening means stressing the castings beyond the elastic limit to give them a permanent set, and this naturally weakens them, but there is always a danger in hot setting of heating above the critical temperature when, in the case of blackheart, the carbon will re-combine with the iron, rendering the casting more or less brittle, and probably useless. This overheating trouble is not likely to occur with whiteheart, as the amount of carbon present is low, and is usually all, or nearly all, present in the combined state. The lower critical temperature of malleable cast iron is about 730 deg. C., so that heating blackheart malleable in the neighbourhood of 700 deg. C., which is only a red heat, is decidedly dangerous.

Structure and Physical Properties.

The structure and fracture of the two materials are entirely different. The names whiteheart and blackheart were derived from the appearance of the fractures. Whiteheart is steely looking and is greyish on the edge, changing to bright coarse white crystals in the core; the line of demarcation is oftentimes well marked.

The microscope shows it to be ferrite on the surface, sometimes with a slight network of oxide of iron, and changing from the edge to the centre with gradually increasing pearlite, until in the centre there is frequently free cementite in sections of ½ in. and over. There is usually a small amount of free carbon in nodular form. Blackheart has a uniform black fracture, except for a slight greyness in the skin. The micro-structure is ferrite throughout, and all the carbon is present in the free state. The surface to a slight depth contains no carbon at all, due to the oxidising effect of the atmosphere in the annealing pots. This slight decarburisation is incidental, and is not sought after at all. The grain size is smaller than in the case of whiteheart, due to the lower temperature of anneal. The high temperature used in whiteheart annealing makes the structure coarse, and if any free carbon is found it is in larger particles than are found in blackheart malleable.

This description of structure of the two malleables is true of the general run of castings, but variations from what has been described are met with, particularly in the case of whiteheart malleable.

Owing to the nature of the annealing process in whiteheart, the section of the casting largely governs the extent of annealing. For example, a casting with a uniform circular section of, say, ¼ in. dia. might well have all but a trace of carbon removed, resembling in properties wrought iron or dead mild steel, whereas a larger casting with sections ¾ in. dia. would, under the same conditions, only be annealed to, perhaps, a ¼ in. or ⅜ in. depth, the centre containing up to 2 per cent. of carbon, practically all being in the combined form, and such a casting would possess no malleability, although being strong and resistant to shock.

It will be readily understood that there is a limit of sections above which the commercial annealing by the whiteheart process produces no malleability at all. There is, however, no limit to the size of blackheart malleable which can be annealed. The section in this case is, as stated before, limited by the size above which it is impossible to make the casting without getting primary graphite. It is essential in both processes, but particularly in blackheart, to produce castings which, before going to the ovens, shall be free, or practically free, from graphite; otherwise, on annealing, the flakes of primary graphite are subject to growth, and in bad cases the iron after annealing consists of a network of graphite, and is weaker than an open-grain cast iron. Primary graphite in whiteheart is not so subject to growth on annealing, owing to the restraining effect of the high sulphur content, and also to the fact that the carbon is largely removed by oxidation, but, in any case, a graphite flake is a source of weakness. To compare the physical properties of the two materials is very difficult, as will be understood when it is realised that there are somewhere in the neighbourhood of 200 firms in this country making malleable cast iron, and, since practice is not standardised, the quality varies very considerably. Not more than about half a dozen of these 200 firms are engaged in making malleable by the blackheart process. The physical properties

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to which most importance is attached are tenacity and ductility. The tensile strength is measured on the unmachined bar. The reason for this appears to lie in the idea that the removal of the surface of the test bar reduces the strength and ductility. In connection with whiteheart, there is some truth in this idea, as the metal is, as a rule, more thoroughly annealed in the surface than in the core, but with blackheart, numerous tests show no loss in elongation, or ultimate tensile values, after the skin has been turned off. However, the continued use of the unmachined bar is undoubtedly stimulated by the expense saved, and, as the material is ductile, the error due to the test piece not being mounted in the machine with its axis in a straight line with the direction of the pull, is negligible. The bar for the tensile test is by no means standardised, and it is a great pity that the latest British Engineering Standards Association's specification is not accepted by all consumers. The tensile value of whiteheart varies from 20 to as much as 30 tons per sq. in., but with the latter tensile strength the elongation is very low. Elongation values on 2 in. have been obtained up to 9 per cent., usual figures for good whiteheart being 23 tons tensile, and 4 to 6 per cent. elongation. Blackheart malleable shows a great superiority in ductility—most of the blackheart produced in this country having an average elongation of over 15 per cent. on 2 in. The tensile strength associated with this is 23 to 25 tons per sq. in. Good blackheart malleable should never show less than 22 tons per sq in tensile, nor 10 per cent. elongation. The yield point of both materials is about the same—namely, 14 to 16 tons per sq. in. All the results mentioned are what might be obtained on the British Engineering Standards Association's test piece "C," having a diam. of 0.564 in. The bend test is nearly always made on a bar 1 in. by $\frac{3}{8}$ in. Good whiteheart gives 45 to 90 deg. bend, and blackheart from 90 to 180 deg on such a bar bend round a 1-in. radius. The British Engineering Standards Association's specification for whiteheart is minimum tensile strength 20 tons per sq. in., and minimum elongation 5 per cent.; and for blackheart, minimum tensile 20 tons per sq. in., and minimum elongation 7½ per cent.

Specifications rarely call for tests other than these. The Izod impact value for blackheart is about 13 to 14 ft. lbs. on the standard Izod notched bar, whilst whiteheart is slightly less than this. A large amount of malleable castings are purchased solely on account of the easy machinability, and this quality is undoubtedly a very important feature of malleable cast iron. Good whiteheart machines more readily than mild steel, but is hardly as good as blackheart. This appears to be due to the presence of free carbon in the blackheart malleable which prevents clogging of the tool. It is claimed for blackheart malleable that it is the most readily machinable of all ferrous products.

The following figures indicate the machinability of blackheart:—Turning and facing a flange of 10 in. dia., a roughing speed was used of 108 ft. per min., the finishing speed was 182 ft. per min.; turning and facing cylindrical piece 6½ in. dia., the roughing speed was 140 ft. per min., the finishing speed was 400 ft. per min. For the turning and given cutting of a light sleeve casting, the rough turning was done at 100 ft. per min., and the finish turning at 235 ft. per min.; the screw-cutting with a single point tool was done at 170 ft. per min. The latest British Engineering Standards Association's specification for malleable requires a machining speed of approximately 90 ft. per min.

An important point with users of malleable is uniformity—and this applies not only to the general malleability of the material, but to machinability. There are so many mass production methods adopted nowadays that it is common to find expensive lay-outs for machining. In such cases it is very important that the castings shall possess uniform cutting hardness, not only in each part, but in each and every batch. One hard casting, or even a hard spot, will sometimes upset a complete lay-out, and cause considerable expense.

Blackheart malleable undoubtedly possesses greater uniformity than whiteheart, due largely to the better knowledge of its metallurgy, and also in a great measure to its simpler annealing process. The manufacture of whiteheart is, however, rapidly improving, and the British Cast Iron Research Association is devoting considerable time and energy to the industry, and its research work in this branch is meeting with considerable success.

As might be expected, the resistance of malleable cast iron to abrasive wear is poor. Whiteheart shows some superiority over blackheart in respect to wearing properties.

Magnetic Properties.

Blackheart malleable cast iron possesses useful magnetic properties. It has high permeability, and very low hysteresis loss and coercive force. Whilst no magnetic data is available on whiteheart malleable, it seems, from a knowledge of its structure, that it would hardly possess the useful magnetic properties to such an extent as blackheart malleable.

It is interesting to note that both whiteheart and blackheart have a greater resistance to atmospheric corrosion than ordinary carbon steel and grey cast iron. This is probably due to the surface being practically carbon-free.

Applications.

It is not intended to enumerate the uses to which malleable cast iron is put, but rather to indicate jobs for which the two types are best suited. For years malleable has been the chief material in the construction of agricultural implements, and in this field whiteheart is quite as suitable as blackheart. A large amount of malleable is used in the chain belt industry, and here, again, there is little to choose between the two types. Amongst the heaviest customers of malleable is the motor industry, where axle cases, differential carriers, dumb irons, hubs, brake parts, and all sorts of brackets are made in malleable. In this industry not only are high strength and ductility of vital importance, but easy machinability is an essential. There is no doubt that blackheart is the most suitable material for motor work from all points of view; hot-water and steam radiators are almost exclusively assembled with malleable cast iron nipples, and since easy and uniform machinability is the chief demand, blackheart is the better type to use. Tramway work, railway stock, and electrical machinery all make demands on the malleable trade. The shipbuilding industry also calls for numerous malleable parts. Malleable is sometimes used as a substitute for cast iron to obtain lightness, and here whiteheart is very suitable. Generally speaking, where strength without ductility, but with some fair resistance to shock, is required, whiteheart is better; particularly is this the case when resistance to frictional wear is a factor. Where high ductility combined with good tensile strength are the dominating requirements, blackheart is the superior material.

Occasionally castings are required which are to be subject to brazing or other heating operations, and in such cases whiteheart should always be used, as blackheart is embrittled if heated even momentarily above 730 deg. C.

For jobs where easy machinability is essential blackheart cannot be improved upon. At the present time blackheart malleable has the wider field of application, and this will probably remain so; but the scope of whiteheart will greatly increase when it can be produced with equal uniformity. Blackheart, by its uniformity, has established a greater confidence amongst users than is possessed by whiteheart. This uniformity of blackheart castings is perhaps the property in which it most differs from whiteheart. When pig-iron producers make more reliable irons, and when whiteheart becomes standardised on scientific lines, and is made from a more reliable melting medium than the cupola, then will it create a confidence amongst users, and be in a position to compare favourably with blackheart malleable cast iron, from the uniformity point of view.

The Mining and Preparation of Silacene.

Our representative recently had an opportunity of inspecting the mining and preparation of the well-known plastic refractory "Silacene."

The material was discovered in the early days of the war by Mr. T. H. Gray, now a director of Messrs. T. E. Gray & Company, Limited, of 119, High Holborn, London, W.C.1, a business founded by his father, the late Mr. T. E. Gray, in 1877, as colliery agents, merchants of foundry coke, ganister, and foundry sands, so that from the time of leaving school in 1906 the son was interested in refractory materials.

Silacene is a natural quartzitic clay found in the East Midlands, the company having acquired options over all places where they are of opinion that this particular stratum shows evidence of occurrence. The principal mine is at Isebrook, and is served by a well-kept siding running from the L.M. & S. main line to the actual working face, a distance of 1,266 yards. The working face, shown in Fig. 2, is 300 yards long, and has an average depth of 20 ft. The clay, owing to an infiltration of silica grains, is exceptionally clean to handle.

After mining, the material is carefully sorted on the benches before being sent down to the mixing mills situated at a point near the main line. Here it is again sorted prior to being milled alone or mixed with other ingredients to render it suitable for its multitudinous applications. From the mills the mixed material falls into wagons directly beneath, which are then hauled up an inclined plane to the main track to be weighed and labelled for despatch to inland users. The mills are capable of producing 50 tons each per eight-hour shift, but during the past three years we understand it has been necessary to work three shifts per day to cope with orders. The power unit is a 40 h.p. Ruston compound steam engine.

Another mine we also inspected was the "Deep Level," some five miles away from Isebrook. This mine is fed by small colliery tubs hauled by an endless wire rope; the material in this case has to be transferred to main line trucks and sent either to Isebrook or the "Midland Works" for treatment. At this mine is situated the blacksmiths' shops for general repair work, and here are made all the tubs, wheelbarrows, and other tools required in the course of mining.

The supervising headquarters are the "Midland Works" (Fig. 1). These works are mainly devoted to the manufacture of side lines, such as Clariflux, a non-ferrous metal flux; Ferromal, a desulphuriser; Ferrocem, a metallic cement; and Silacene, plastic fine cement. One shop is devoted to grinding coal dust and plumbago, another specialises in the manufacture of parting powder, and a third is set aside for packing Silacene for export, a very important branch of the company's business; and whilst our representative was there three important consignments were being prepared for shipment to Australia, Burma and Nigeria. The Midland Works are well situated for dealing with export trade, being on two branches of the L.M. & S., giving quick access to ports of shipment, and the train ferry at Harwich for Continental buyers.

Fig. 1.—The Midland Works of Messrs. T. E. Gray & Company, Limited.

Fig. 2.—The Working Face at Isebrook Quarry.

Fig. 3.—Silacene on its Way from the Mine to the Mixing Mills.

On the Malleable Cast Iron and the Mechanism of its Graphitisation.

By Tario Kikuta (Research Laboratory, Tobato Foundry Company, Tobato, Japan).

(*Continued from page* 412.)

The effect of the temperature of the mould on the first stage graphitisation is shown below:—

TABLE III.

Temperature of mould.	Green sand.	Dry sand.	400.	600.	800.	1,000.
Time required to complete the first stage of graphitisation:—						
No. 5	5*h* 0*m*	6*h* 0*m*	7*h* 30*m*	9*h* 30*m*	9*h* 20*m*	10*h* 0*m*
No. 6		8 0		11 20	14 0	15 20
(annealing temp. = 925°).						

If the casting (No. 7) with the chemical composition C, 2.28; Si, 1.02; Mn, 0.31; S, 0.034; and P, 0.126, be made in an iron mould, the graphitisation takes place more easily, as is seen from Table IV.

TABLE IV.

Annealing temperature.	870°	905°	950°
Time required for the first stage of graphitisation	9*h* 0*m*	4*h* 30*m*	2*h* 30*m*

From these results one can understand that the graphitisation is strongly influenced by the size of free cementite or the thickness of the casting.

The effect of the thickness on the second stage of graphitisation was next studied, the results obtained being given as in Table V. The specimen used was the same as No. 5 and it was tested after the completion of the first stage of graphitisation.

TABLE V.

Temperature of mould.	Dry sand.	400°	600°	800°
Time required to complete the second stage of graphitisation ...	15*h*	22*h*	21*h*	22*h*

The effect of the thickness of casting on the second stage of graphitisation is less than that on the first stage, and it is almost *nil*, except in the case of a specimen cast in a dry-sand mould.

The Effect of Tapping Temperature of the Melt on the Graphitisation.

Scarcely anything is known of the extent to which the graphitisation is affected by the tapping temperature of the melt, but it is of some importance, since in recent years an electric furnace has come to be extensively used in melting the material for malleable cast iron. In the present investigation a material (No. 8) containing C, 2.70; Si, 0.98; Mn, 0.30; S, 0.018; and P, 0.11, was melted in a melting tube by means of a Tammann furnace. The temperature was measured with a Pt, Pt-Rh thermocouple which was calibrated by measuring the melting point of pure metal, and cast in a dry-sand mould when it attained a desired temperature.

The result obtained is shown in Table VI.

TABLE VI.

Tapping temperature.	1300°	1350°	1400°	1450°	1500°	1550°
Time required to complete the first stage of graphitisation ...	5*h*	5*h* 30*m*	6*h* 20*m*	7*h* 0*m*	8*h* 0*m*	8*h* 20*m*

From this result it is evident that the graphitisation is affected by the tapping temperature to a fairly large extent. The graphitisation becomes more difficult as the tapping temperature is raised higher. This is probably explained by the maximum temperature to which the melt is heated; because the amount of CO or CO_2 gas absorbed in the melt diminishes as the temperature is raised, and hence the graphitisation becomes more difficult.

EFFECT OF CHEMICAL COMPOSITION ON THE GRAPHITISATION OF MALLEABLE CAST IRON.

A few investigations have been published on the effect of various elements on the graphitisation of white cast iron, but for some reason or other they are not applicable to the practical case. Hence the present writer has made a more thorough study of this effect on the graphitisation throughout the practical range of the malleable-iron foundry, so that the results obtained, if we make the corrections which were obtained in the foregoing paragraph, would be applicable in practice. The elements which were studied in the present investigation are those which are generally found in malleable cast iron, *i.e.*, silicon, carbon, manganese, sulphur and phosphorus. As regards other elements, the writer intends to investigate them in a continuation of this work.

The melt was cast in a sand mould, and from the same melt he made a test piece for the tensile testing of two cylindrical rods, 8 mm. thick and 20 cm. long, for the dilatation test

In the dilatometric investigation the length of the specimen was 10 cm., and the temperature was kept constant at 925 deg. for the first stage of graphitisation and at 710 deg. for the second stage. When the content of manganese was increased, however, the temperature had to be kept below 710 deg. for the second graphitisation, since the transformation point is shifted towards the lower temperature.

TABLE VII.—*Alloys containing 2 per cent. Carbon.*

Sample No.	C.	Si.	Mn.	S.	P.
11	1.99	0.88	0.21	0.022	0.113
12	2.03	0.98	0.25	0.027	0.110
13	1.99	1.15	0.19	0.020	0.112
14	2.09	1.22	0.24	0.023	0.122
15	2.02	1.35	0.23	0.022	0.126
16	2.02	1.47	0.24	0.027	0.117
17	1.97	1.87	0.18	0.030	0.117
18	1.95	2.22	0.22	0.026	0.114

TABLE VIII.—*Alloys containing 2.4–2.5 per cent. Carbon.*

Sample No.	C.	Si.	Mn.	S.	P.
19	2.42	0.58	0.25	0.023	0.086
20	2.44	0.77	0.21	0.027	0.101
21	2.45	0.86	0.19	0.029	0.115
22	2.50	0.97	0.18	0.031	0.138
23	2.48	1.03	0.16	0.031	0.124
24	2.42	1.07	0.17	0.028	0.134
25	2.53	1.21	0.17	0.031	0.137
26	2.42	1.35	0.16	0.023	0.132
27	2.39	1.51	0.16	0.029	0.127
28	2.41	1.64	0.19	0.028	0.129

Effect of Silicon.

A series of alloys shown in the next tables were made by mixing the above-mentioned materials. The contents of manganese, sulphur, and phosphorus were almost constant, those of silicon and carbon being varied.

TABLE IX.—*Alloys containing 2.8–2.9 per cent. Carbon.*

Sample No.	C.	Si.	Mn.	S.	P.
29	2.87	0.63	0.20	0.013	0.069
30	2.89	0.77	0.16	0.020	0.100
31	2.87	1.01	0.18	0.021	0.100
32	2.84	1.23	0.17	0.021	0.095
33	2.86	1.39	0.18	0.014	0.090

The fracture of specimen No. 33 was already black in the initial state, showing that it was graphitised during the cooling from the melt. With such a material, even with complete graphitisation, we could hardly obtain good results either in the tensile strength or in the elongation tests, so that alloys containing 2.8 to 2.9 per cent. of carbon and more than 1.20 per cent. of silicon were not further tested in the present investigation.

(1) *Alloys containing 2.0 per cent. of carbon.*—The result obtained in these alloys is shown in Table X.

TABLE X.

Sample No.	Si (%).	Time required to complete the first stage of graphitisation.
11	0.88	15*h* 0*m*
12	0.98	11 0
13	1.15	7 20
14	1.22	6 30
15	1.35	4 30
16	1.47	3 40
17	1.82	2 0
18	2.20	1 0

(2) *Alloys containing 2.5 per cent of carbon.*—As the specimens belonging to this series were most favourable for the malleable iron foundry, the writer has studied the effect of silicon on the first as well as the second stage of graphitisation. From the dilatation curves it was found in some cases the graphitisation occurs soon after the A_{r1} point is passed and the rate of

TABLE XI.

Sample No.	Si.	Time required to complete graphitisation.	
		First stage.	Second stage.
19	0.58	16*h* 0*m*	—
20	0.77	11 0	—
21	0.86	9 0	25*h* 0*m*
22	0.97	7 0	—
23	1.03	6 0	—
24	1.07	5 30	16 0
25	1.21	4 10	12 0
26	1.35	3 20	9 0
27	1.51	2 50	6 0
28	1.64	2 30	5 30

TABLE XII.

Sample No.	Si.	Time required to complete graphitisation.	
		First stage.	Second stage.
29	0.63	17*h*	—
30	0.77	12	—
31	1.01	8	—
32	1.23	5 30*m*	7*h* 30*m*

graphitisation is rapid at first, decreasing gradually afterwards. On the other hand, the quantity of cementite graphitised at the second stage becomes less as the content of silicon increases. This is due to the smaller amount of eutectoid cementite separating at the A_{r1} transformation as a result of the displacement of the solubility line of cementite. The relations between the time required to complete the first and second stages of graphitisation and the contents of silicon are shown in Table XI.

(3) *Alloys containing 2.85 per cent. of carbon.*—In this case, only Table XII, which shows the results of experiments, is given, other remarks being omitted to avoid repetition.

Effect of Carbon.

To examine the effect of carbon, in addition to that of the above alloys, additional specimens were prepared, their composition is given in Table XIII.

TABLE XIII.

Sample No.	C.	Si.	Mn.	S.	P.
34	1.48	0.82	0.24	0.030	0.107
35	1.65	1.23	0.26	0.028	0.114
36	3.50	0.79	0.20	0.014	0.066
37	3.44	0.91	0.20	0.017	0.051

If the content of carbon be increased to 3.5 per cent. and the silicon contained be more than 1.0 per cent., the fracture of specimens is mottled with some graphite flakes, and such material cannot be used in malleable iron casting. The results obtained in the present investigation are shown in Table XIV, in which the contents of phosphorus are shown, as the phosphorus has a better effect on the graphitisation.

TABLE XIV.

Sample No.	C.	Si	P.	Time required to complete first stage of graphitisation.
20	2.44	0.77	0.101	11*h*
30	2.87	0.77	0.100	12
36	3.50	0.79	0.066	10
34	1.48	0.82	0.107	7
11	1.99	0.88	0.113	15
21	2.45	0.86	0.115	9
37	3.44	0.91	0.051	11
35	1.65	1.23	0.114	4
14	2.09	1.22	0.122	6 30*m*
25	2.53	1.21	0.137	4 10
32	2.84	1.23	0.095	6 0

Referring to the above table, it will be seen that the effect of carbon against the graphitisation is almost constant in specimens containing 0.77 per cent. of silicon, and in those containing 0.80 to 0.90 per cent. of silicon only a small fluctuation is noticeable. For those containing 1.20 per cent. of silicon, the same element has no great effect, if we take the effect of phosphorus into consideration. That is, the effect of the carbon in the graphitisation of the first stage is not great. For the second stage of graphitisation, the following results were obtained as shown in Table XV.

TABLE XV.

Sample No.	C.	Si.	Mn.	S.	P.	Time required to complete second stage of graphitisation.
14	2.09	1.22	0.24	0.023	0.122	25*h*
25	2.53	1.21	0.17	0.031	0.137	12
32	2.84	1.23	0.17	0.021	0.095	7 30*m*

The carbon has a slight effect on the first stage of graphitisation or the decomposition of free cementite, but has a strong effect on that of the second stage or that of eutectoid cementite. If the content of carbon is increased, the temper carbon is formed at a higher temperature resulting in an increase in the number of grains. On the other hand the eutectoid cementite is graphitised from the boundary of temper carbon; hence the second stage of graphitisation is accelerated by the temper carbon. In malleable iron foundry practice, the articles which have been re-annealed are generally known to be unsatisfactory, since some of the pearlitic zones

still remain. This is probably due to the decrease of carbon caused by burning when the articles are heated at a high temperature for a long time. For instance, when ten specimens of various chemical compositions were taken and their chemical analysis was made before and after the annealing, the mean loss of carbon in one operation was 0.40 per cent. It has been also frequently noticed in annealed malleable iron casting that the pearlitic zone appears near the edge of the fracture, which fact may be also explained in the same manner as above.

TABLE XVI.

Sample No.	C.	Si.	Mn.	S.	P.	Time required to complete graphitisation.	
						First stage.	Second stage.
47	2.62	1.15	0.22	0.026	0.126	5h 0m	10h at 710°
40	2.51	1.15	0.46	0.033	0.127	5 30	24 at 700
41	2.61	1.20	1.02	0.033	0.130	7 0	53 at 690
42	2.64	1.12	1.26	0.024	0.136	8 0	
43	2.64	1.15	1.81	0.013	0.134	13 0	
44	2.72	1.15	2.11	0.022	0.129	22 0	
45	2.66	1.11	3.16	0.013	0.133	25+ x*	

* Specimen No. 45 suffered no graphitisation, even when it was heated at 925° for 25 hours.

TABLE XVII.

Sample No.	C.	Si.	Mn.	S.	P.	Time required to complete graphitisation.	
						First stage.	Second stage.
46	2.45	1.24	0.26	0.007	0.061	8h	6h 20m
47	2.62	1.15	0.22	0.026	0.126	5	10
48	2.50	1.14	0.22	0.051	0.121	6	15
49	2.54	1.14	0.22	0.066	0.128	7	23
50	2.45	1.15	0.22	0.072	0.120	7 30m	22 + x*
51	2.66	1.11	0.22	0.104	0.130	9	
52	2.61	1.13	0.21	0.152	0.129	11	
53	2.54	1.12	0.24	0.202	0.125	16	

Mark * in the above table shows that there was no graphitisation at the second stage at all, though the specimen was heated to 710° for 22 hours.

Effect of Manganese.

The specimens used in this investigation were made in the same manner as those for the former test, and their chemical composition and the time required to complete the graphitisation are shown in Table XVI. In the case of the second stage of graphitisation, as the content of manganese was increased, the temperature at which the specimen was kept constant was made somewhat lower than 710 deg. on account of the lowering of the transformation point.

In order to show the progress of graphitisation, curves were plotted, in which the ordinate denotes the dilatation of the specimen and the abscissa the time of exposure at 925 deg. In comparing these curves, it is known that more time is required to complete the first stage of graphitisation, as the content of manganese is increased, though there is no remarkable change at the beginning of the graphitisation; microscopic examination after the test shows that there remain some very small particles of free cementite in the pearlitic ground and it would require a very long time to graphitise those small particles of cementite entirely. From the relation between the time for graphitisation and the content of manganese, it is concluded that the graphitising time is increased logarithmically with the content of manganese. For the second stage of graphitisation, the effect of manganese is very remarkable and it is almost impossible to obtain perfect graphitisation in malleable iron foundry practice if the manganese content is over 1 per cent. Hence, the writer considers it is suitable to limit the content of manganese to below 0.5 per cent.: and even in the presence of a fair amount of sulphur, manganese is not favourable to graphitisation.

Effect of Sulphur.

The chemical compositions of the specimens used and the results obtained in the present investigation are given in Table XVII.

The progress of graphitisation as shown by dilation curves indicates that it becomes more difficult for the graphitisation to begin as the content of sulphur increases, and also that after the beginning of graphitisation there is no remarkable change in the graphitising rate up to a 0.10 per cent. of sulphur. Specimen No. 46 was somewhat difficult to graphitise though the content of sulphur was small. This is probably due to the small content of phosphorus. For the second stage of graphitisation, the effect of sulphur is very much greater than that of manganese; hence, in the black heart malleable iron iron foundry, it is necessary to limit the content of sulphur to 0.06 per cent. for material which contains about 2.50 per cent. of carbon. (The chemical analysis of sulphur was made by the evolution method).

(To be continued.)

Personal.

SIR ALFRED YARROW has made a donation of £10,000 to the funds of the British Association for the Advancement of Science.

MR. H. MORRIS, previously Liverpool manager of Joseph Cort, Limited, and afterwards with Mr. S. Bamber, Blackburn, has been appointed manager of the scrap iron and steel department of Frank Young & Son, The Arcade, Liverpool.

MAJOR J. L. BENTHALL has resigned from the board of Vickers, Limited, and vacated his appointment as special director in charge of the armour-plate department at Sheffield. He has been in the service of Vickers, Limited, for 33 years, and has been a Sheffield director of the company for 16 years. His introduction to engineering and a business career took place at the Poplar shipyard of J. d'A. Samuda Bros., then controlled by his grandfather. Major Benthall intends to take up other work in the New Year.

MR. FRANK HUDSON, who left England for the United States some two years ago, is returning home next month to be married. His object in visiting America was to study their methods and conditions in the iron and steel industry, especially chilled iron. He was associated prior to his trip with Sir W. G. Armstrong, Whitworth & Company, Limited, as personal assistant to Mr. Oliver Smalley, their then research metallurgist. His many friends can get in touch with him at 28, Curtis Road, Fenham, Newcastle.

Will.

DUMBELL, J. S., partner in Thomas Turner & Company, lock manufacturers and brass founders, of Brickkiln Street, Wolverhampton £8,826

HAMPTON, MR. WILLIAM ERNEST, of St. Agnes Road, Moseley, Birmingham, iron-founder 7,539

The International Foundrymen's Convention at Detroit.

The Tour of Overseas Foundrymen under the Auspices of the American Foundrymen's Association.

(*Continued from page* 433.)

By Our Special Correspondent.

Buffalo, a magnificent city, with wide thoroughfares and many splendid residences, was reached about 10 p.m. by a hot and thirsty crowd of limp pilgrims, knowing not whether they suffered most from the heat at the beginning of the journey, the cold at the end, or the draughts all the way through.

The railroad was the Lehigh Valley, a company which tries to make its passengers comfortable and feeds them well. The route was via Bethlehem, past the great steel plant of that name, through an industrial valley filled with works and evidences of the abundance of fuel, by the side, for many miles, of the noble river Susquehanna, up the steep wild valleys of the Alleghany Mountains, with their wealth of minerals, past Kalamazoo (famous for ledgers) and Wilkes Barre, right through the heart of the anthracite coal district, by the shores of Lake Cayacu, a great sheet of water with its own navigation, its own piers, and even its own lighthouses.

On Board the "Lancastria."

The Group includes Mr. John Cameron, Mr. Frank Russell, Mr. W. B. Lake, Mr. W. Jolley, and Mr. J. M. Primrose.

A City of Electricity.

Buffalo, being within a few miles of the stupendous power stations of Niagara Falls, is fortunate above all other cities in an ample supply of electricity, so cheap that it does not pay to use anything else for any purpose for which electricity is suitable.

Everything in Buffalo is electrified, and many were the interesting works the scattered travellers visited the day after their arrival, and enthusiastic were their stories. Your scribe can tell of no first-hand experiences in this way, being otherwise and less amiably engaged, but a friend noted a spaciousness, a dignity, a confidence, about the large scale industrial plants of Buffalo, which was as impressive as was the variety of their products, for Buffalo does not put all its eggs in one basket by any means.

An Astounding Advertising Stunt.

In this city was first encountered the real typical American advertising stunt. An ill-advised gentleman had, we understood from the massive newspaper with which we were presented free each morning, been unwise enough to back himself to drive a motor-car without a stop or pause, for no less than five days' running, without sleep, rest, or relief, ever and always through the streets of the city, crowded by day and lonely by night. Oil, petrol, water and food had to be taken on board en route, and if he failed in one jot or tittle to adhere strictly to the local traffic arrangements, he "lost out" and had missed his rest in vain. When we saw him he had been at his self-imposed task for two days, and though he looked a bit sleepy we could believe he might succeed. For all we know his driving may have become a habit and he may be still threading his weary way along the Buffalo paths to the advantage of the maker of the car, the tyres, the oil and the petrol, known as "gasoline" and sold at 10½d. a gallon with "two quarts of oil thrown in free if you take five gallons."

This is "that good Gulf Gasoline," or "Sinclair," or one of a dozen brands each running its own filling stations—not a word about "Pratts," or "Shell" and not a whisper about "Standard Oil."

The Buffalo Banquet.

Heartily were the delegates made welcome to Buffalo, by a jolly group headed by Mr. James W. Gibney. Their programme was concise and to the point. It commenced at 8.30 a.m. on Saturday, September 25, and outlined a full day. From 9 to 12 was dedicated to the visitation of plants, 12 to 2 to refreshment of the inner man, 2 to 5 a sight-seeing trip and at 7 p.m. the travellers were hospitably bidden to a feast, of which an unforgettably luscious "Roast Long Island Duckling" was the *pièce de resistance*, with "peas panachée" and apple fritters to accompany, and "peach plombiere" the coping-stone, so to speak, of a culinary triumph. Weak, however, were the brethren in the morn, after the far from perfect day before; the weather was unkind, and few indeed were those who saw the McKinley Monument, which was the rendezvous for a photograph to be taken in the cold grey dawn at 8.30 a.m.

The Toastmaster.

The Toastmaster, Mr. Gibney, was no round man in a square hole, and admirably did he fill the chair, introducing the Mayor, Mr. Frank S. Swann, who in a happy speech for the Foundrymen of Buffalo, extended a hearty welcome to the visitors and hoped they would find their stay enjoyable and instructive. He said that in a dry, dry land Buffalo had the reputation of being a wet city, but he desired unduly to raise no hopes nor to create misapprehension. He referred to their climate, which, if it really was damp—he wouldn't admit that it was—but if it *was* damp, it was because of the mist which was produced by the "backfire" from the Falls of Niagara.

He concluded by a reference to American hospitality and said the Revd. Charles D. Broughton (who had opened the proceedings with an Invocation) would hold a special service at 9.30 for those who fear they may not be able to stand the strain, and there would be a special prayer for those who were already down and out

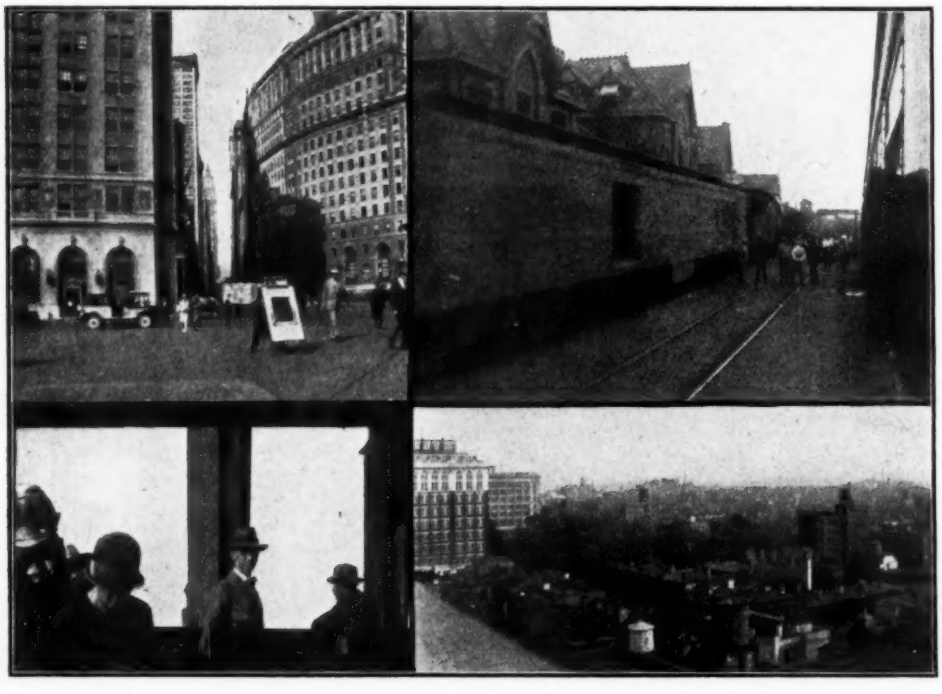
pounds a week, and that care for the men's welfare and the improved sanitation introduced by the employers definitely without outside pressure, had reduced illness, accidents, and the consequent absenteeism by no less than 60 per cent.

The Act for the Compensation of Injured Workmen was introduced by the employers for the benefit of the men, and he felt that so long as the present spirit of the foundry industry was maintained there was neither place nor use for Trade Unionism, and he did not fear that it would ever regain formidable strength or become a menace to the trade.

A Useful Idea.

The neat programme and menu card, in the form of a booklet, and which usefully contained a full list of the overseas delegates, their descriptions and addresses, was prized by all who received it, many of the visitors finding it of much service during the rest of their trip.

It included the name of the ever-welcome and eloquent Mr. H. Cole Estep amongst the speakers,



LEFT HAND TOP—BROADWAY, NEW YORK CITY. RIGHT TOP—THE BRITISH PARTY AT KALAMAZOO STATION. BOTTOM LEFT—MR. S. H. RUSSELL ON THE TOP OF THE WOOLWORTH BUILDING. BOTTOM RIGHT—PHILADELPHIA CITY. PHOTOGRAPHS BY COURTESY OF MR. T. H. GRAY.

—a reference to two of the party who had succumbed to the ravages of "waffles" and ice-water, and had taken to their beds.

Moulders of Opinion.

Mr. William H. Barr, the President of the National Founders' Association, addressed himself particularly to the ladies, who were, he said, the Moulders of Foundrymen's Opinions, and thus well qualified to the present. He dealt statistically with the foundry industry in the U.S.A., confidently asserting that 3½ h.p. was available for each man employed in a foundry.

Dwelling on the work of the Association of which he was President, he said that it was formed for a purpose. It set out to perform the difficult task of convincing the men that it was definitely to their interest to increase output, and that their interests were one with those of their employers. It had succeeded in its task so thoroughly that though thirty years ago eighty thousand out of a hundred thousand men were in the Moulders' Unions, to-day less than 20 per cent. were union men, and under 10 per cent. of American foundries were staffed by union men, or acknowledged the unions in any way.

He continued that in the "open," or non-union shops, the average earnings of a floor moulder were about forty-five dollars, or nine

and addresses by delegates included one by Mr. H. S. Russell, Junior Vice-President of the I.B.F., who spoke ably and to the point, and to the high satisfaction of all his compatriots, thanking the Buffalo foundrymen for the real sincerity of their welcome, for their hospitality, and complimenting them upon their beautiful city and their flourishing industry.

Two Well-Known Foundrymen Honoured.

Just recently two prominent foundrymen have been made Justices of the Peace. One is Mr. W. B. Lake, of Messrs. Lake & Elliot, of Braintree. He took the oath on his return from America where he attended the Detroit Conference. The second recipient is Major Appleyard, the general manager of the Birtley Iron Company, Limited.

The Major is one of the most go-ahead of the younger generation of foundrymen, who has ideals which he does not hesitate to put into practice.

These two gentlemen are both vice-presidents of Branches of the Institute of British Foundrymen. On behalf of the industry we offer them our sincere congratulations.

Foundry Purchasing.—IV.

By ERIC N. SIMONS.

Some of the characteristic qualities the buyer must possess have been hinted at in the previous articles, but it now becomes necessary to specify these a little more intimately. First, one may discuss the question of the original choice of a buyer by a founder definitely establishing a central buying department. It is obvious to any with the slightest acquaintance with business conditions and requirements that one thing of more importance than any other is the moral trustworthiness of the official to whom this important position is given. For this reason, it is seldom policy to accept the services of an outside person, unless he has behind him a record of long service with a firm of good reputation, and has only left their employment at the instigation of the firm he is about to join. If an outside man is chosen, he should always—exceptional circumstances apart—be actually in employment at the time of his engagement. The reason is obvious. Firms know too well the value to themselves of good and honest buyers to part with them unless there are good motives for so doing. A purchasing official out of employment must of necessity lie open to suspicion, not necessarily of moral failings, but of incompetence, extravagance, negligence, or other faults.

Exceptional circumstances have been mentioned. Perhaps a brief amplification of this phrase will clear away a few misconceptions that the earlier sentences may have occasioned. A buyer may sometimes be thrown out of his position by reason of the failure or bankruptcy of the firm that has employed him. He may have lost his post through prolonged illness, or may have voluntarily resigned it because of disagreement with his employers on matters of pure policy. In such instances, he need not be ineligible for consideration because of his immediate lack of occupation. But if applications from outside men are entertained it is essential, whoever be the candidate, to inquire fully into his past circumstances, his reputation, the reputation of his former employers, and the causes, if any, of his unemployment or desire to change.

Whether the man be new to the firm or one already known and trusted, he will have to possess certain qualities. First, he must have sound judgment, not only of human beings, but of business. It is far too commonly assumed that to make a successful buyer a man must have some innate "flair" or instinct that enables him to tell just when and when not to buy. Analysing this contention, it resolves itself into nothing more or less than a belief in lucky guessing. But "luck guessing" is exactly what its name implies, an untrustworthy foundation on which to build one of the most important of all business operations. Long experience in business dealings with other men will, and often does, give a shrewd buyer an almost subconscious ability to decide when is the most opportune moment to conclude a transaction; but this is not guesswork. It is the outcome of time, and of sound qualities that every buyer who wishes to succeed must have. To suggest that it is the origin of these qualities is to put the cart before the horse.

The successful buyer must have foresight, tact, balance, initiative, moral stability, commonsense, and as much practical knowledge of the goods he has to buy as he can accumulate. Perhaps tact is the most important of all these characteristics. It will enable him to work harmoniously with production managers and managers of departments, with works foremen and storekeepers, with even ordinary "hands," since these often sway the decisions of foundry foremen or managers on such matters as the choice of tools, equipment, and so forth. It will also be of great value to him in his dealings with salesmen, since by careful handling he can obtain from these latter information and hints on economical purchasing that otherwise he might solicit in vain.

Foresight will instruct him when to buy advantageously. For instance, the knowledge that civil war is likely to break out in a certain supplying country—gathered from a careful study of the daily newspaper or trade journal—and that in consequence prices for a particular raw material are likely to rise owing to shortage during the period of hostilities, will cause him to lay in stocks while the market prices are still normal, instead of waiting until hostilities have actually broken out, with an immediate sharp rise. Foresight will also, at times, indicate to him when it is expedient to withhold purchases in expectation of a drop in prices. Further stress need not be laid on this point.

Balance, in the sense in which the word is used here, implies what is more commonly called level-headedness. Its significance is that it prevents the buyer from getting "rattled," to use a slang phrase. There are occasions when panic seizes a market, and if the buyer allows himself to fall a prey to the common ailment, he may lose thousands of pounds or sums proportionate to the extent of his activities, either by buying huge stocks rashly in the belief that a shortage is coming, or by refusing to buy cheap lots from fear of a drop in prices. The scaremongering of certain popular daily papers is particularly liable to attack an unbalanced buyer, and the writer has seen more than one instance of fingers badly burned through too much attention having been paid to the headlines of the journals in question.

Initiative is as essential as foresight. It is the force that prompts a buyer to action. Obviously it is useless to detect by foresight the right moment to buy or to withhold from buying if the courage and energy requisite for the seizing of the moment are lacking, so that it is allowed to pass. A buyer, perhaps more than any other official, has to learn to rely upon his own judgment at critical moments. He cannot always wait for the sanction of the board of management, but must conclude a bargain on the spot. It is the initiative of the buyer that decides how often he will turn his opportunities into achievements.

Moral stability is a far-reaching term, but it is the keynote of the buyer's success. In the main, supplying firms are honest and straightforward in their methods, but there are certain manufacturers or dealers less scrupulous, often in proportion to the inefficiency of their products or goods. These survive not so much because their materials are worthy buying, as through their ingenuity in penetrating a buyer's moral defences and gaining him over to their side by surreptitious and dishonourable methods. Therefore, they are ever on the look-out to detect the moral weakness of a buyer, so that they may, by pandering to it, suborn him. However much one may desire to overlook the fact, it is nevertheless true that a good deal of bribery is still to be found in the realms of business. Every buyer has on more than one occasion had offers made to him by salesmen that involved a pecuniary benefit to himself in return for orders. The result is usually not very pleasant for the salesman concerned; but the point it is sought to make is that, ever and again, some supplier will be found ready to take advantage of the slightest weakness on the buyer's part. If he drinks, he will find the salesman a "good fellow," ready to take him out to lunch or dinner and fill him with as much as he can hold, until he is in such a condition that his ordinary business judgment is temporarily in abeyance. If he gambles, the salesman will be ready to lend him money to tide over financial embarrassments—in return, of course, explicitly or implicitly, for favourable consideration when orders have to be placed. And so it goes on. It is not for a moment suggested that these methods are typical, either of buyers or of suppliers. In a later article the writer will have some further remarks to make on this subject of bribery; but for the present he has said enough to convince readers that moral stability is an indispensable requirement in any purchasing official, whatever his rank.

Common sense, which every man believes himself to possess—often wrongly—is that quality that prevents a man from swallowing too greedily the pretentious claim, the plausible excuse, the fantastic argument. It is the counterpart of balance, and implies a first-hand acquaintance with the realities of a situation, whether in everyday life or in business.

XUM

Trade Talk.

A FIRE OCCURRED RECENTLY at the works of Thomas Firth & Sons, Limited, Sheffield, resulting in considerable damage.

AN OUTBREAK of fire occurred recently in the pattern store belonging to J. Bertram & Son, Leith Walk Foundry, Leith. A large number of patterns were destroyed.

UNDER THE LATEST ascertainment of selling prices of steel, Mr. A. Pugh, secretary of the Iron and Steel Trades Confederation, announces that the smelters' sliding scale will be advanced 5 per cent.

CLARK, CHAPMAN & COMPANY, LIMITED, of Gateshead, have received the contract from the London County Council for the boilers for the Grenwich power station. The contract is worth over £15,000.

SIR KINGSLEY WOOD has stated that the number of steel or cast-iron houses, the erection of which had been authorised in England and Wales, was 993, excluding those erected for demonstration purposes.

A. AND J. MAIN AND COMPANY, LIMITED, Australia House, Strand, London, W.C.2, and Possilpark, Glasgow, N., have acquired a controlling interest in Main Ropeways, Limited, 47, Victoria Street, London, S.W.1.

PALMERS SHIPBUILDING AND IRON COMPANY, LIMITED, Jarrow, have booked an order for three oil-carrying vessels of about 10,000 tons deadweight, each on account of the British Tanker Company, Limited.

SUMNER, MAYOH & HALEY, LIMITED, Westminster, London, S.W., have received intimation that their plans for a system of underground tube railways for Buenos Aires had been approved by the Municipal Council of that city.

THE GT. YARMOUTH PORT AND HAVEN COMMISSIONERS, in conjunction with the local Corporation, have given to Sir William Arrol & Company, Limited, Glasgow, the contract for a new bridge across the Yare, costing £200,000.

THE WORKS AND FOUNDRY of Isaac Hill & Son, Limited, who recently went into liquidation, have been purchased at auction by the Derby Co-operative Society for £3,900. The property comprises 3,680 square yards of land and buildings.

OFFICIAL CONFIRMATION was received last week by Swan, Hunter & Wigham Richardson, Limited, of Wallsend-on-Tyne, that they have been awarded the Admiralty contract for the construction of the floating dock at Singapore Naval Base, to lift 50,000 tons, of the dimensions 850 ft. long and 170 ft. wide.

ORDERS FOR THREE STEAMERS, of 5,800 tons deadweight capacity, have been placed by H. Hogarth & Son, Glasgow, with Lithgows, Limited, Port Glasgow, Napier & Miller, Limited, Old Kilpatrick, and the Ayrshire Dockyard Company, Limited, Irvine, respectively. The engines for the Lithgow order will be supplied by J. G. Kincaid & Company, Limited, Greenock, and for the other vessels by David Rowan & Company, Limited, Glasgow.

CONSIDERING THE STATE of the trade, good prices were realised at the sale of the plant and machinery at the Woods Lane works, Derby, of Isaac Hill & Son, Limited, who recently went into liquidation An 11-inch lathe and an 8-inch lathe made £29 each, a milling machine realised £29, a planing machine £32, a gear-cutter £36, two drilling machines £34 and £32 respectively, and a fireproof safe £24. A 10-ton travelling crane, with all accessories and driving-pulley driven by square shafts, went for only £10.

LAST WEEK, Sir George Hume, J.P., M.P., the chairman of the London County Council, opened at Battersea "Watson House," a scientific and technical training centre of the Gas Light and Coke Company, practically reproducing, in a modern form, all the best points of the old apprenticeship system. At Watson House, boys entering the gas industry from elementary and secondary schools will have the chance of eventually reaching responsible positions, without any initial advantages other than perseverance and ability. This is the result of a quarter of a century's endeavour on the part of Mr. David Milne Watson, Governor of the Gas Light and Coke Company.

Company Reports.

Johnson and Phillips, Limited.—Interim dividend, 5 per cent. actual, less tax.

South Durham Steel and Iron Company, Limited.—Dividend, 5 per cent. on ordinary shares for year.

John I. Thornycroft & Company, Limited.—Dividend, 3 per cent. on ordinary; carry forward, £51,293.

Dorman Long & Company, Limited.—No dividend on 8 per cent. non-cumulative preferred ordinary, or on ordinary.

Yarrow & Company, Limited.—Profit, £11,729; brought forward, £2,749; available balance, £14,478; dividend, 7½ per cent. for year; carried forward, £3,228.

Obituary.

MR. J. G. WILSON, works manager of the Deepcar department of J. Grayson Lowood & Company, Limited, has died at his residence, "The Uskers," Deepcar.

MR. J. E. PARKIN, of Milton House, Dore Road, Sheffield, died on November 11, at the age of 54 years. He was well known as a director of the firm of George Senior & Sons, Limited, Ponds Forge, Sheffield. A cousin of Mr. Albert Senior, and nephew of the late Alderman George Senior, he commenced his association with the Ponds Forge as an office boy at the age of 14, going there straight from school. By diligent study he afterwards became an incorporated accountant and he was made a director of the firm in 1915.

MR. MICHAEL JOSEPH HUNTER, J.P., a former Master Cutler, died on November 11, at his residence, Carisbrooke, Oakholme Road, Sheffield. Mr. Hunter, who was 70 years of age, was apprenticed in his father's business at the age of 17. In 1883 the late Mr. Hunter was made a partner in the business, the premises of which have for long been known as Talbot Works. His father died in 1898, and the following year the son took the not unimportant step of converting the business into a private limited liability company, with himself as chairman and Mr. Thomas T. Hardy, who had been connected with the Talbot Works since 1866, as managing director. The firm then became known as Michael Hunter & Son, Limited.

Contracts Open.

Dalkey, Ireland, November 30.—Water mains (4-in. cast-iron turned and bored water mains), with valves, etc., for the Urban District Council. Mr. J. G. Treston, town clerk, Town Hall, Dalkey.

Doncaster, November 29.—Providing and laying 1,500 yards of 6-in. cast-iron pipes (Contract No. 11), 150 yards of 9-in. and 3,367 yards of 12-in. cast-iron pipes (Contract No. 12), and 2,220 yards of 9-in. cast-iron pipes (Contract No. 13), for the Corporation. Mr. F. O. Kirby, water engineer, 2, Priory Place, Doncaster. (Fee £1 1s. for each contract, returnable.)

Dublin, December 7.—(6) Chains; (14) iron castings, etc.; (16) nails, etc.; (22) rivets, screws, bolts, nuts and washers; (25) structural steel for shipbuilding and wrought iron, for 12 months ending December 31, 1927, for the Dublin Port and Docks Board. Mr. E. H. Bailey, secretary, Port and Docks Office, Westmoreland Street, Dublin.

Durban, S.A., December 10.—Sluice valves (Tender No. W. 96), for the Borough of Durban, Borough Water Engineer's Department. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 3,847.)

Durban, December 10.—3,550 cast-iron spigot and socket pipes, Class "C," assorted, together with a quantity of specials (Contract No. W. 95), for the Borough of Durban, Borough Water Engineer's Department. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 3,848.)

Durban, December 16.—Waterworks fittings (Contract No. W. 97), for the Borough of Durban, Borough Water Engineer's Department. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 3,850.)

London, S.E.1, November 30.—(2) 690 tons mild-steel angles, flats, rounds and squares; and (3) 180,000 feet of railway signal point rodding in 1¼-in. M.S. rod or plugged tubing. The Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 5s. per set, non-returnable.)

Penrith, December 6.—(Contract No. 1) ¾ mile 2-in. diameter cast-iron pipes, 35½ miles 3-in. ditto, 20 miles 4-in. ditto, 3¼ miles 5-in. ditto; ¼ mile 7-in. ditto, 1¼ mile 5-in. diameter steel pipes, ditto, with valves, etc.; also for construction of break-pressure tanks and valve chambers; (Contract No. 2) construction of three service reservoirs in mass concrete, together with valve chambers, valves and cast-iron specials, for the West Ward (Westmorland) Rural District Council. Mr. J. J. Davison, engineer, 6, King Street, Wigton, Cumberland. (Fee £5, returnable.)

Pontypridd, November 30.—Steel mains and specials, for the Gas Department of Pontypridd Urban District Council. Mr. David Muir, engineer and manager, Gasworks, Treforest, Pontypridd.

Trevor, December 6.—Small concrete service reservoir (45,000 gallons capacity) and intake works, etc.; also 2,810 lineal yards of cast-iron spigot and socket pipes, 4-in. and 3-in. internal diameter, for the Lleyn Rural District Council. Messrs. T. B. Farrington & Sons, engineers, Trinity Square, Llandudno. (Fee £3 3s., returnable.)

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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—With the return of the miners to work, after a protracted if futile struggle, interest in the Cleveland iron market is now centred on the earliest possible date upon which the resumption of production at the furnaces can be assured with something like positive certainty. This, however, is a question complicated by a variety of factors, more or less important, the first being naturally how soon the local coke producers can resume delivery of the indispensable fuel supplies. This must necessarily take some time, and the price which will be fixed also enters into calculation when quotations for pig-iron have to be adjusted for forward delivery. In the circumstances thus outlined, it is estimated that very little iron can be promised with assurance much before the New Year, while prices must needs depend upon the current costs of production in the future. The whole position is one of unprecedented difficulty and uncertainty, and for the time being it would seem that traders can hardly do otherwise than "wait and see." In the meantime, and for a while longer, business is merely hand to mouth, and previous quotations are maintained, as follow:—No. 1, 125s.; No. 3 G.M.B., 120s.; No. 4 foundry, 119s.; and No. 4 forge, 118s. 6d. per ton.

Conditions in the Tees-side hematite market correspond exactly with those applying to foundry pig, no iron being available of the ordinary grades. It is suggested that after the resumption the price of mixed numbers may settle down for a brief period at about 85s. to 90s. per ton, but at the moment this is mere conjecture, no forward business having apparently been attempted. On the North-West Coast prices remain very firm, with only a limited volume of business possible at the moment.

LANCASHIRE.—A more cheerful view of the future is now entertained in local pig-iron markets, but pending some definite assurance of an early resumption of work at the furnaces, business is still restricted within very narrow compass. Prices continue at high levels, Scottish No. 3 having made round 140s. per ton, delivered into the Manchester area, and Middlesbrough about 137s. 6d. per ton, with miscellaneous offers of East Coast foundry iron at 132s. 6d., and off-grade lots of hematite at 120s. There is very little imported pig-iron available on spot, but there are numerous offers for shipment from Continental ports.

THE MIDLANDS.—Here again consumers are awaiting developments in connection with the Derbyshire and neighbouring ironmasters' intentions in relighting plants, and until these are ascertained, buying is virtually suspended. Meanwhile, heavy tonnages of No. 3 foundry grade have been purchased by the Midland ironfounders from abroad, and the iron has yet to come in. Many of the bigger consumers have covered themselves until February for foreign pig.

SCOTLAND.—No change can be reported in the condition of the Scotch pig-iron market, with prices unchanged at 115s. to 120s. for No. 3, f.o.t. furnaces. There is perhaps a shade more desire on the part of holders to dispose of their iron, no doubt due to the change in the coal situation.

Finished Iron.

For the first time for many months more animation is to be noted in the various markets for finished material, the prospect of an early return to normal fuel conditions inspiring a feeling of confidence that the worst has been surmounted. Production, however, is still limited to a few makers of best-quality bars, for which prices are still maintained at previous high levels, about £16 per ton, delivered. At Birmingham offers of foreign No. 3 bolt iron have been submitted, the current quotations being £6 17s. 6d. delivered here for January shipment. There is still a fair amount of business going to the Belgian works, and this state of affairs is likely to obtain for some time, as it is certain that the English ironmakers will not be able to produce bolt iron within pounds of this figure.

Steel.

So far as the semi-products branch of the industry is concerned, business continues uneventful, producers still being hampered by the high costs of manufacture and scarcity of fuel. British semis are not available and the merchants who have been handling imported steel are marking time. Neither they nor their customers want to buy foreign semis at round £6 7s. 6d. delivered, which is now the price of soft billets, unless it is impossible to get British on better terms. For November-December delivery tinplate quotations range round 25s. 6d. basis for cokes, net cash, f.o.b. Wales, but prices are very "wide," transactions being reported at as low as 25s., and at as high as 26s. 6d. Home consumers are the principal buyers for near dates, a moderate export inquiry resulting in very little business.

Scrap.

There is no change of importance to be noted in the scrap metal markets, although inquiries are now reported as increasing in volume. This is, at all events, the case in Scotland, heavy machinery cast-iron scrap still maintaining its price on account of the scarcity and fairly good demand, and lots are still changing hands around 85s. to 87s. 6d. per ton, and for ordinary around 77s. 6d. per ton. Old cast-iron railway chairs are also firm around 84s. to 85s. per ton, and foundries are still anxious to obtain supplies, although good quantities are rather difficult to obtain. Light cast-iron scrap is quiet around 57s. 6d. to 60s. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—The position of standard copper at present continues almost stationary, consumptive demand having been for some weeks below the normal average, while the lower prices cabled from America of late are by no means an encouraging factor. There has, however, been an extension of forward sales of standard metal, and the market is certainly down to a point which should induce better support, while the home stocks have been reduced, in spite of some increase in the holdings of refined copper.

Official closing prices of standard copper have been as follow :—

Cash: Thursday, £57 2s. 6d. to £57 5s.; Friday, £57 to £57 2s. 6d.; Monday, £57 to £57 2s. 6d.; Tuesday, £57 to £57 2s. 6d.; Wednesday, £56 17s. 6d. to £57.

Three Months: Thursday, £58 to £58 2s. 6d.; Friday, £57 17s. 6d. to £58; Monday, £57 17s. 6d. to £58; Tuesday, £57 17s. 6d. to £58; Wednesday, £57 12s. 6d. to £57 15s.

Tin.—The steady improvement in the home industrial situation and the favourable effect of the recent statistical returns have been promptly reflected in a steady upward trend of standard values, which at the week's end disclosed an advance of £5, largely due to "bear" covering. The outlook as regards the current month is by no means viewed in a pessimistic light, while it is rather surmised that the reports circulated suggesting deterioration in American industrial conditions have been exaggerated.

Official closing prices of standard tin have been as under :—

Cash: Thursday, £314 5s. to £314 10s.; Friday, £309 to £309 10s.; Monday, £312 to £312 2s. 6d.; Tuesday, £316 10s. to £316 15s.; Wednesday, £313 to £313 5s.

Three Months: Thursday, £301 5s. to £301 10s.; Friday, £298 to £298 5s.; Monday, £300 10s. to £300 12s. 6d.; Tuesday, £302 10s. to £302 15s.; Wednesday, £300 to £300 5s.

Spelter.—Consequent upon the recent fuel shortage, the demand for spelter for galvanising production has slowed down and the market has been correspondingly quiet without affecting values to any great extent. On the Continent, however, smelters are evidently anticipating an improvement and are selling very little for export.

The following are the week's prices :—

Ordinary: Thursday, £33 8s. 9d.; Friday, £33 2s. 6d.; Monday, £33 6s. 3d.; Tuesday, £33 13s. 9d.; Wednesday, £33 10s.

Lead.—In the market for soft foreign pig, limited buying on consumptive account explains the renewed weakness in this metal. However, the comparatively low price engenders caution amongst sellers, the technical position is sound and the industrial situation is improving, so that, with returning confidence, prices may be expected to recover.

The week's prices are appended :—

Soft foreign (prompt): Thursday, £29 2s. 6d.; Friday, £28 18s. 9d.; Monday, £29 1s. 3d.; Tuesday, £29 7s. 6d.; Wednesday, £29 3s. 9d.

MR. WALTER SCOTT, metallurgist to Guest, Keen & Nettlefolds, Limited, Cardiff, gave a paper before the Metallurgical and Mining Society, at Cardiff University, on November 12, on "Steel Practice and Manufacture in the Basic Open-Hearth."

A PROMINENT FALKIRK IRONFOUNDER has passed away in the person of Mr. Thomas Downie, a director of Grahamston Iron Company, Limited. He began his business career with the firm in 1876, and during the last twelve years of his life held the position of chairman of the company. He was widely known throughout the kingdom in the light castings industry, and his advice was often sought and acted upon at important conferences of the trade.

COLTNESS IRON CO., LTD.

Makers of the well-known and old-established

"COLTNESS" BRAND OF HIGH CLASS SCOTCH PIG IRON

FOUNDRY. No. 1, No. 3, No. 4.	STANDARD GRADES	HEMATITE. No. 1, No. 3, No. 4.

Works:— Newmains, Lanarkshire.

PRICES, ANALYSES, ETC., MAY BE OBTAINED ON APPLICATION TO THE GLASGOW OFFICE.

Office:— 75, Bothwell St., Glasgow, C.2.

"GUTMANN" ROTARY TABLE

WITH BUILT-ON

Direct Pressure Sand Blast Apparatus

THIS NEW DESIGN EMBODIES VERY IMPORTANT ADVANTAGES:—

THE SAND SUPPLY IS WHOLLY AUTOMATIC.

NO INTERMEDIATE PIPES ARE REQUIRED BETWEEN THE SAND BLAST APPARATUS AND THE MACHINE.

PERFECT SEPARATION OF THE USED SAND IS ENSURED.

COMPLETE FREEDOM FROM DUST.

SOLE BRITISH AND COLONIAL AGENTS:

T. FEARNLEY ALLEN & SON

51, Norwich Union Chambers, Congreve Street, BIRMINGHAM

Telephone: Central 543. *Telegrams: "Sandblo" Birmingham.*

Ground Ganister,

Steel Moulders' Composition,

Silica Bricks, Refractory Goods.

PICKFORD, HOLLAND & Co., Ld., SHEFFIELD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	56	17	6
Three months ..	57	12	6
Electrolytic	65	0	0
Tough	62	15	0
Best selected ..	63	7	6
Sheets	92	0	0
India	73	10	0
Wire bars	65	10	0
Do. December ..	65	0	0
Do. January ..	65	0	0
Ingot bars	65	0	0
H.C. wire rods ..	69	15	0
Off. av. cash, Oct.	58	7	3⅝
Do., 3 mths. Oct.	59	3	10⅞
Do., Sttlmnt. Oct.	58	7	3½
Do., Electro. Oct.	66	10	10
Do., B.S., Oct. ..	65	4	8⅝
Aver. spot price copper, Oct. ..	58	7	3
Do., wire bars, Oct.	66	15	8½
Solid drawn tubes			13d.
Brazed tubes ..			13d.
Wire			9¼d.

BRASS.

Solid drawn tubes ..	12d.
Brazed tubes	13¾d.
Rods, drawn	11¼d.
Rods, extd. or rlld. ..	7¼d.
Sheets to 10 w.g ..	10½d.
Wire	10¼d.
Rolled metal	10½d.
Yellow metal rods ..	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets ..	8¼d.

TIN.

	£	s.	d.
Standard cash ..	313	0	0
Three months ..	300	0	0
English	311	0	0
Bars	316	10	0
Straits	325	10	0
Australian	320	15	0
Eastern	310	0	0
Banca	325	10	0
Off. avr. cash, Oct.	312	14	6⅝
Do., 3 mths., Oct.	303	14	3⅞
Do., Sttlmt. Oct.	312	13	9½
Aver. spot., Oct.	312	14	6¼

SPELTER.

	£	s.	d.
Ordinary	33	10	0
Remelted	32	15	0
Hard	27	5	0
Electro 99.9 ..	36	5	0
English	34	5	0
India	30	10	0
Zinc dust	43	0	0
Zinc ashes	15	0	0
Off. aver., Oct. ..	34	4	0⅜
Aver., spot, Oct.	34	5	1½

LEAD.

	£	s.	d.
Soft foreign ppt.	29	3	9
English	30	15	0
Off. average, Oct.	30	15	2½
Average spot, Oct.	30	16	5

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	42	10	0
Do. V.M. ex whf.	39	10	0
Rods	45	0	0
Boiler plates ..	39	0	0
Battery plates ..	38	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	74	10	0
Chinese	57	0	0
Crude	38	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver ..	17	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon —			
25%	9	2	6
45/50%	11	0	0
75%	17	0	0
Ferro-vanadium—			
35/40%	14/- lb. va.		
Ferro-molybdenum—			
70/75% c. free ..	5/- lb.		
Ferro titanium—			
23/25 % carbonless	1 1½d.		
Ferro-phosphorus, 20/25%,	£17	0	0
Ferro-tungsten—			
80/85%, c.fr. ..	1/5 lb.		
Tungsten metal powder—			
98/99% ..	1/9 lb.		
Ferro-chrome—			
2/4% car. ..	£32	0	0
4/6% car. ..	£23	5	0
6/8% car. ..	£21	15	0
8/10% car. ..	£20	10	0
Ferro-chrome—			
Max. 2% car.	£36	0	0
Max. 1% car.	£42	0	0
Max. 0.70% car.	£54	0	0
70%, carbonless	1/5 lb.		
Nickel—99%, cubes or pellets ..	£170		
Cobalt metal—98/99%	8/6 lb.		
Aluminium 98/99%	£104		
Metallic Chromium—			
96/98% ..	3/- lb.		
Ferro-manganese (net)—			
76/80%, loose	£16	0	0
76/80%, packed	£17	0	0
76/80%, export	£16	0	0
Metallic manganese—			
94/96%, carbonless	2/- lb.		
Per ton unless otherwise stated.			

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten ..	2	6
Finished bars, 18% tungsten ..	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. and over ..	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Do. under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do. under ½ in. × ¼ in.	1/- lb
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—	£	s.	d.	£	s.	d.
Hvy. steel	2	15	0 to	3	5	0
Bundled steel & shrngs. ..	2	5	0			
Mixed iron & steel	2	10	0 to	2	15	0
Heavy cast iron	2	15	0 to	2	17	6
Good machinery for foundries	3	2	6 to	3	7	6
Cleveland—						
Heavy steel ..	3	0	0			
Steel turnings ..	2	7	6			
Cast iron borings	2	5	0			
Heavy forge ..	4	2	6			
Bushelled scrap	3	10	0			
Cast-iron scrap	3	11	6 to	3	15	0
Lancashire—						
Cast-iron scrap	3	10	0			
Hvy. wrought ..	3	2	6			
Steel turnings ..	1	17	6			
London — Merchants' buying prices delivered yard.						
Copper (clean)..	48	0	0			
Brass (clean) ..	37	0	0			
Lead (less usual draft)	26	10	0			
Tea lead ..	22	0	0			
Zinc	23	0	0			
New aluminium cuttings ..	82	0	0			
Braziery copper	44	0	0			
Gunmetal ..	46	0	0			
Hollow pewter	190	0	0			
Shaped black pewter ..	140	0	0			

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast —	
Foundry No. 1 ..	125/-
Foundry No. 3 ..	120/-
Foundry No. 4 ..	119/-
Forge No. 4	118/6
Hematite No. 1 ..	—
Hematite M/Nos. ..	—
N.W. Coast—	
Hem. M/Nos. d/d Glas.	—
„ d/d Birm. ..	—
Midlands—	
Staffs common* ..	—
„ No. 4 forge ..	—
„ No. 3 foundry	—
Shrops. basic	—
„ Cold blast, ord.*	—
„ „ roll iron* ..	—
* d/d Birmingham.	
Northants forge	—
„ fdry No. 3 ..	—
Derbyshire forge ..	—
„ fdry. No. 3 ..	—
„ basic	—
Scotland—	
Foundry No. 1 ..	—
„ No. 3 ..	117/6
Hem. M/Nos. ..	—
Sheffield (d/d district)—	
Derby forge	—
„ fdry. No. 3 ..	—
Lincs. forge	—
„ fdry. No. 3 ..	—
E.C. hematite	—
W.C. hematite ..	—
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3.. ..	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3 ..	—
Northants foundry No. 3	—
Dalzell, No. 3	140/-
Summerlee, No. 3 ..	140/-
Glengarnock, No. 3 ..	—
Gartsherrie, No. 3 ..	140/-
Monkland No. 3	140/-
Coltness, No. 3	140/-
Shotts, No. 3	140/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom. ..	12	10	0 to	16	0	0
Angles			—			
Tees to 3 united ins.			—			
Nut and bolt iron			—			
Hoops	14	10	0			
Marked bars (Staffs.) f.o.t. ..			—			
Gas strip	12	10	0			
Bolts and nuts .. ¾ in. × 4 in. ..	15	5	0			
Steel—						
Ship plates	8	12	6			
Boiler plts. ..	11	5	0			
Chequer plts. ..	9	15	0			
Angles	7	17	6			
Tees	8	17	6			
Joists	7	17	6			
Rounds and Squares 3 in. to 5½ ins. ..	8	10	0			
Rounds under 3 in. to ¾ in. (Untested)	9	0	0 to	11	10	0
Flats, over 5 in. wide and up ..	9	10	0			
Flats, 5in. to 1½in.	8	10	0			
Rails, heavy ..	8	10	0			
Fishplates	12	10	0			
Hoops (Staffs.) ..	10	10	0			
Black sheets, 24g.	12	2	6			
Galv. cor. sheets, 24g.	17	10	0			
Galv. fencing wire 8g. plain	12	10	0			
Billets, soft 7/15/0 to	10	0	0			
Billets, hard ..			—			
Sheet bars	7	10	0			
Tin bars d/d.. ..	7	10	0			

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to 10 w.g. ..	1	3½
Wire	1	4
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	23.26
No. 2 foundry, Valley	19.00
No. 2 foundry, Birm.	20.00
Basic	20.26
Bessemer	21.76
Malleable	20.76
Grey forge	20.26
Ferro-mang. 80% d/d	95.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	2.00
Skelp, grooved steel ..	1.90
Skelp, sheared steel ..	1.90
Steel hoops	2.50
Sheets, black, No. 24..	3.00
Sheets, galv., No. 24 ..	3.85
Sheets, blue an'l'd, 9 & 10	2.30
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv. ..	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
„ furnace	—
Durham & North.	
„ foundry	—
„ furnace	70/-
Other Districts, foundry	—
„ „ furnace (basis)	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	26/-
„	28×20, „	52/-
„	20×10, „	—
„	18¾×14, „	—
C.W.	20×14, „	—
„	28×20, „	—
„	20×10, „	—
„	18¾×14, „	—

Terneplates 28×20, — per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£18/10 to £19/0
Rolled Ord.	£15/10/0 to £16
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£9 to £12
Pig-iron	£6 0 0 to £6 10 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes	*Fittings*
Gas ..	60%	.. 50%
Water ..	55%	.. 45%
Steam ..	50%	.. 40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.		
Nov. 18	57	2	6	dec.	10/-
,, 19	57	0	0	,,	2/6
,, 22	57	0	0	No change	
,, 23	57	0	0	,, ,,	
,, 24	56	17	6	dec.	2/6

Electrolytic Copper.

	£	s.	d.		
Nov. 18	65	10	0	No change	
,, 19	65	10	0	,, ,,	
,, 22	65	5	0	dec.	5/-
,, 23	65	0	0	,,	5/-
,, 24	65	0	0	No change	

Standard Tin (Cash).

	£	s.	d.		
Nov. 18	314	5	0	dec.	25/-
,, 19	309	0	0	,,	105/-
,, 22	312	0	0	inc.	60/-
,, 23	316	10	0	,,	90/-
,, 24	313	0	0	dec.	70/-

Tin (English ingots).

	£	s.	d.		
Nov. 18	312	5	0	dec.	25/-
,, 19	307	0	0	,,	105/-
,, 22	310	0	0	inc.	60/-
,, 23	314	10	0	,,	90/-
,, 24	311	0	0	dec.	70/-

Zinc Sheets (English).

	£	s.	d.		
Nov. 18	42	10	0	No change	
,, 19	42	10	0	,, ,,	
,, 22	42	10	0	,, ,,	
,, 23	42	10	0	,, ,,	
,, 24	42	10	0	,, ,,	

Spelter (ordinary).

	£	s.	d.		
Nov. 18	33	8	9	dec.	3/9
,, 19	33	2	6	,,	6/3
,, 22	33	6	3	inc.	3/9
,, 23	33	13	9	,,	7/6
,, 24	33	10	0	dec.	3/9

Lead (English).

	£	s.	d.	
Nov. 18	30	15	0	No chang
,, 19	30	10	0	dec. 5/-
,, 22	30	10	0	No change
,, 23	30	15	0	inc. 5/-
,, 24	30	15	0	No change

Exports of Iron Castings in October and the ten months 1926, compared with October and the ten months, 1925.

	October, 1925.	October, 1926.	Ten months, 1925.	Ten months, 1926.	October, 1925.	October, 1926.	Ten months, 1925.	Ten months, 1926.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers—								
To Argentine Republic	129	197	1,311	1,285	4,734	6,028	47,602	51,107
,, British South Africa	402	372	3,165	3,633	13,403	12,435	110,768	123,190
,, ,, East Indies	149	140	1,448	1,489	6,910	6,936	66,409	65,725
,, Australia	79	37	604	693	4,421	2,609	33,951	39,455
,, New Zealand	283	286	2,310	2,047	13,147	14,184	107,761	100,024
,, Other countries	808	917	6,636	6,956	43,050	46,628	337,833	338,111
Total	1,850	1,949	15,474	16,103	85,665	88,820	704,324	717,612
PIPES AND FITTINGS—CAST—								
To Argentine Republic	742	443	9,870	7,071	9,522	5,693	126,907	86,406
,, British South Africa	238	612	5,435	6,385	4,454	8,922	78,759	89,186
,, ,, India	808	465	8,199	6,926	12,640	6,188	118,144	89,684
,, Straits Settlements and Malay States	613	315	5,068	13,826	6,134	3,417	59,220	119,619
,, Ceylon	96	168	1,093	1,729	1,332	2,376	13,754	20,188
,, Australia	220	285	2,635	3,377	3,584	6,563	42,602	49,017
Other countries	4,796	3,610	46,976	39,287	71,462	60,719	691,753	559,142
Total	7,513	5,898	79,276	78,601	109,128	93,878	1,131,139	1,013,242
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	734	599	6,896	5,581	24,812	21,794	232,277	195,955
,, Enamelled	89	76	838	816	8,980	8,825	86,280	88,015
CASTINGS, in the rough—								
Iron	311	49	1,431	1,157	11,365	2,508	50,714	33,708
Steel	132	25	689	574	6,677	1,434	29,399	18,170

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